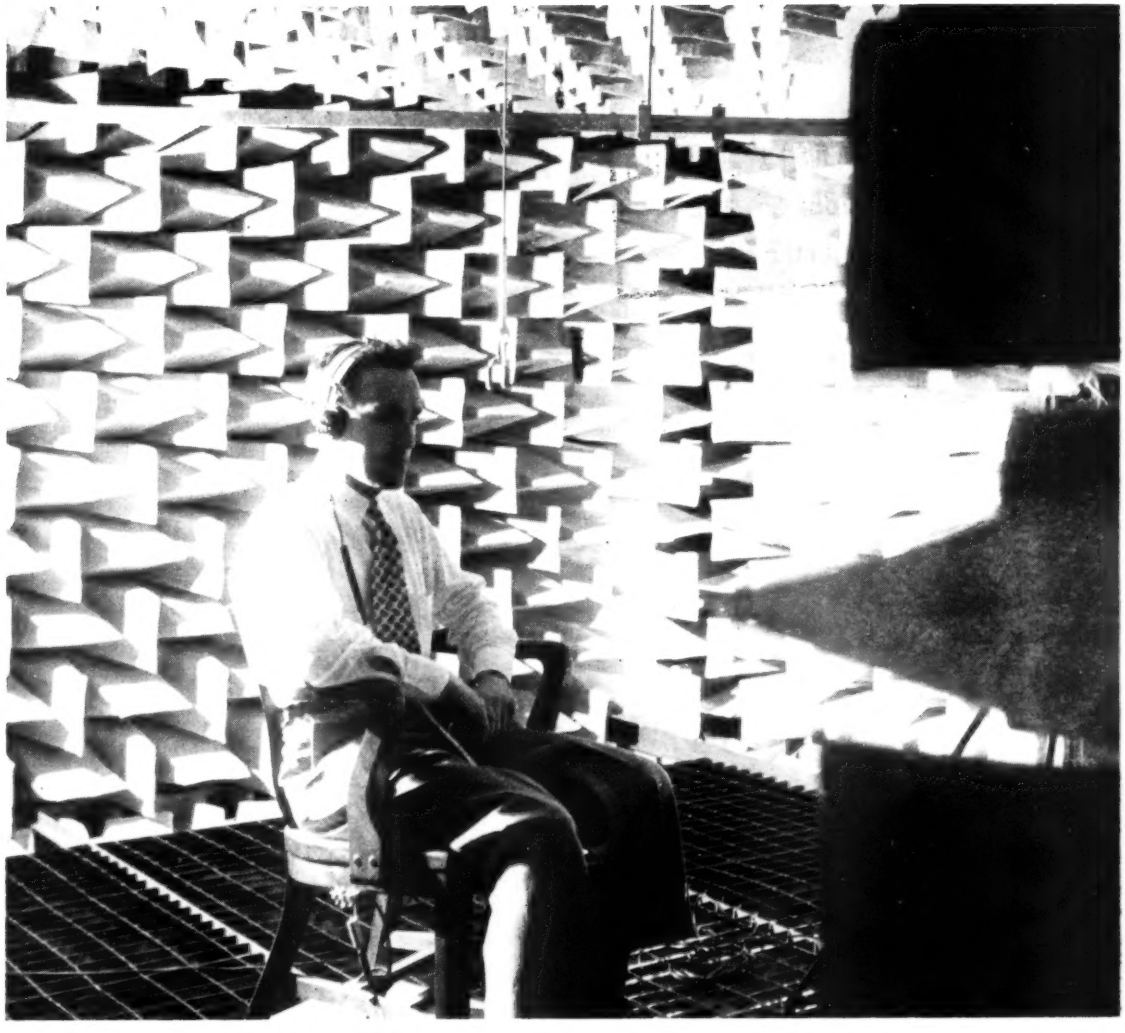
Midwest Engineer

SERVING THE ENGINEERING PROFESSION

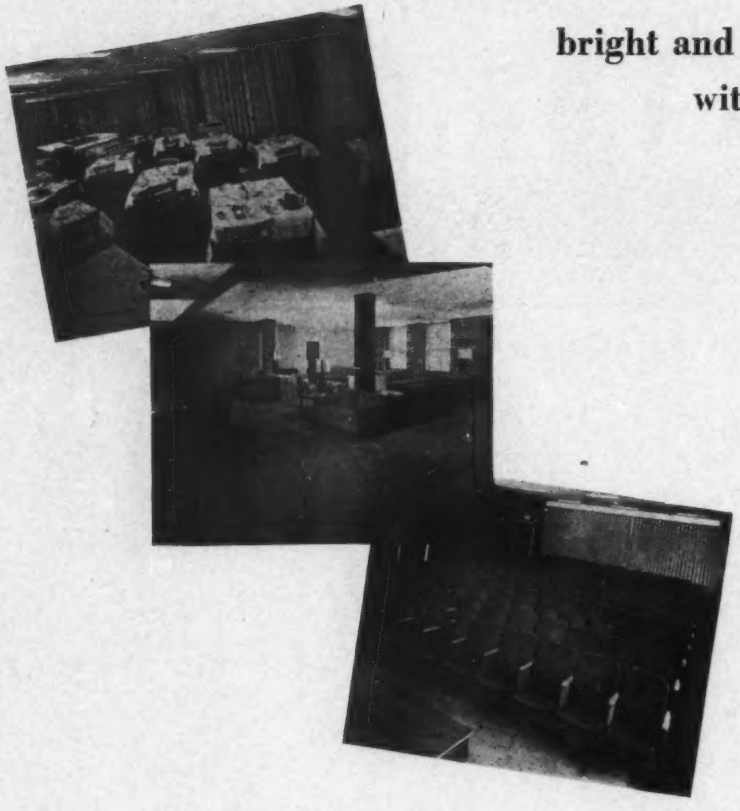


WESTERN SOCIETY OF ENGINEERS
FOUNDED 1869

SHORTAGE OF ENGINEER GRADUATES
WSE MEETING NOTICES—PAGE TWO

Vol. 8 APRIL, 1951 No. 8

Spring forecast for WSE members:



bright and sunny days at headquarters with showers of events

- *Every Thursday Luncheon meeting 12:15-1:30 p.m. $1.15*
- *Every Monday general evening meetings Film-6:45 p.m., Meeting-7 p.m.*
- *June 4th Annual Meeting Furniture Club*
- *Every weekday:*
- *Relax in the Lounge*
- *Browse through the books and magazines*
- *Meet your friends and family*
- *Dine leisurely or speedily, as you prefer*
- *Luncheon - 11 a.m.-2 p.m.*
- *Dinner - 5:30 p.m. - 8 p.m.*

Headquarters of The Western Society of Engineers

No need to check your almanac to know that WSE headquarters offers you all the advantages of a much more expensive club. Plus, a flood of excellent technical meetings.

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MIDWEST ENGINEER

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WESTERN SOCIETY OF ENGINEERS

Serving the Engineering Profession

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COVER CREDIT

Subject in the anechoic chamber of Parmly Foundation for Auditory Research. Story on page 9.

April 2, Toll Road Engineering

SPONSORED JOINTLY BY THE TRANSPORTATION AND TRAFFIC AND CITY PLANNING SECTIONS

The "Engineering and Construction Aspects of Toll Roads" will be developed for WSE members when the Transportation and Traffic sections present the second phase of their series of discussions on toll roads. **Mr. Charles E. DeLeuw,** former trustee of the Western Society of Engineers, will bring his extensive knowledge and experience to the discussion of this controversial problem of toll roads.

Mr. DeLeuw is president of DeLeuw Cather, consulting engineers specializing in traffic and transportation problems.

April 9, Significance of Mechanical Seal

SPONSORED BY THE MECHANICAL SECTION

The mechanical seal, a comparatively new tool that has been revolutionary in its ability to solve problems confronting a wide range of industries, will be the subject of the paper "Significance of the Mechanical Seal on Your Trip Through Industrial America," to be given by **Mr. Carl E. Schmitz,** vice president and director of engineering, Crane Packing Company.

Mr. Schmitz's paper will be accompanied by slides showing construction and application in industrial and military installations. It will also include a firm covering the latest developments in production lapping machinery. Mr. Schmitz is a member of the Western Society of Engineers, and he represented WSE at the National Conference for Industrial Hydraulics.

April 16, Lake Michigan Shore Erosion

SPONSORED BY THE HYDRAULIC, SANITARY AND MUNICIPAL SECTION

A cooperative study of the erosion of Lake Michigan shores in the Chicago area has recently been completed by the Corps of Engineers and the State of Illinois. This report will be the topic of a talk before WSE by **Colonel Russell A. Thompson** (WSE). Colonel Thompson is principal engineer, Corps of Engineers, U. S. Army, Chicago District.

Colonel Thompson's talk, "Lake Erosion Study—Illinois Shore Line," will include a description of the existing shore line, with special reference to common erosion problems, an analysis of the factors involved and the recommendations on corrective measures. Of special interest to the Society should be the discussion of the methods employed in securing and analyzing the data.

April 20, Atom Smasher Excursion

The Institute for Nuclear Studies, University of Chicago, will be hosts to Western Society of Engineers, on their excursion, April 20.

WSE will inspect the U. of C. cyclotron and betatron and hear a short descriptive talk, "Purpose and Operation of Particle Accelerators." Make reservations for groups beginning promptly at 6:30 p.m., 7:15 p.m. and 8 p.m., by calling RAndolph 6-1736. Only 100 can be accommodated in each group. Tours begin at Eckhardt Hall, University of Chicago campus.

April 23, Industry and Oxygen Recorders

SPONSORED BY THE GAS, FUELS AND COMBUSTION SECTION

Mr. William H. Pugsley, vice president in charge of field research for the Hays Corporation, will discuss the general application of oxygen recorders to industrial processes and varied fields of application. His talk, "Oxygen Meters in Industry," will incorporate slides to demonstrate various methods by which oxygen is determined by currently available instruments and sampling methods used.

Mr. Pugsley has a background of 25 years in the instrument industry and is a member of the ASME, Instrument Society of America and Iron and Steel Engineers. As an added feature of his talk, Mr. Pugsley will demonstrate a Hays oxygen analyser recorder.

April 30, Section Membership Drive

SPONSORED BY THE FIRE PROTECTION AND SAFETY ENGINEERING SECTION

This meeting of the Fire Protection and Safety Engineers Section will launch that section's own campaign for more WSE members. A panel discussion on the advantages and reasons why fire protection and safety engineers should become members of a society, such as Western. Each member of the fire protection and safety engineering section will be asked to bring two non-member fire protection or safety engineers.

May 7, Power in the Chicago Area

SPONSORED BY THE ELECTRICAL SECTION

"The Chicago District Power System" will be the title of a talk by **Titus LeClair** before the WSE Electrical Section's final meeting of the season.

At that time Mr. LeClair, chief engineer of the Commonwealth Edison Company and past president of WSE, will outline the expansion program of Commonwealth Edison and describe the new generating facilities. His talk will be illustrated with slide.

May 14, Engineers and National Affairs

SPONSORED BY THE COMMUNICATIONS SECTION

Mr. Francis X. Welch, managing editor, "Public Utilities Fortnightly," and Washington editor, "Telephony" will be on hand to talk to WSE on affairs in the nation's capital and how they effect engineers. Mr. Welch is an able analyst of political affairs and his talk should be of great interest to all engineers.

Thursday Noon Luncheon—Meetings

Every Thursday noon WSE members gather at headquarters for a double feature meeting. The bill of fare includes a man-sized meal, for $1.15, and a rapid fire speaker who holds his listeners' attention with a short, pertinent talk.

First Forum Meeting—Challenging

WSE's initial Young Engineers' Forum got off to a rousing good start at its first dinner meeting, March 13th. Arriving early, 102 young engineers, representing 25 different companies in the Chicago area, gathered in the lounge to meet fellow trainees and active WSE members.

As each trainee entered WSE headquarters he received an oversized name tag complete with company affiliation, a guest card, dinner ticket and Forum program. During the length of the Forum each trainee is entitled to the same privileges afforded regular members. Forum members may use WSE dining and lounge facilities, come to the general meetings and participate in the excursions and special Society parties.

During the hour of fellowship the young engineers were introduced to each other and met the 25 WSE hosts. By the end of the first pre-dinner period the trainees were calling one another by their first names, knew each others' jobs and were beginning to feel at home at WSE headquarters.

At dinner the seating was arranged so that one WSE member would be at each table of eight. In this way, the young engineers would feel free to develop their own conversations and ideas, but would also become closer acquainted with WSE members, objectives and the Forum plan. Trainees will change tables at every session, thereby allowing them to come in closer contact with more young engineers and active members.

After dinner Gustav Egloff, general chairman of the Forum, welcomed the young engineers and reminded them that the Forum would be of slight value unless they used the question session to full advantage. At that time the trainees could quiz the speaker or any other WSE members on questions that bothered them.

Clarence Elder, chairman of the Communications Section, introduced the Forum speaker, Bill Kahler, president of the Illinois Bell Telephone Company. Bill Kahler, who rose from a Missouri farmboy to become one of Utilities, outstanding leaders.

The thesis of Bill Kahler's talk summed up to perfection the objectives of the Young Engineers' Forum. He maintained, "An engineer, in order to be of maximum value to society, must be a well-rounded individual who is capable of understanding and evaluating a great deal more than his own job in our complex industrial system and certainly more than the strictly technical engineering aspects of the problem he's dealing with at the time. He must be engineer, business man, financial expert, public relations counsellor, and citizen, all rolled into one."

Mr. Kahler pointed out just how important engineers are to industry. He estimated that engineers will be responsible for expenditures in industry of approximately 22 billion dollars in 1951.

After giving the Forum a general picture of the engineer in industry, Mr. Kahler dug into the mysteries of the utility field. He discussed "natural" monopolies and utility investments.

Tom Ayers, manager of industrial relations of Public Service Company of Northern Illinois, led the question session. Questions were decided upon by individual table groups taking five minutes out to develop. This session proved that the young engineers in the Forum are tops in intelligence and ability, and that their companies are completely justified in choosing them for the course.

Companies cooperating with the Young Engineers' Forum are: Armour & Company, Armour Research Foundation, Becker Equipment and Supply Company, Carnegie-Illinois Steel (Gary and South Works), Chicago Bridge and Iron Company, Commonwealth Edison Company, DeLeuw, Cather & Company, General Electric Company, Bruce A.

(Continued on Page 24)

The following are a few comments heard from members and trainees after the first Forum:

Donald N. Becker (WSE), A. J. Boynton & Co., "The men at my table were very much interested in the program . . . This is a wonderful method of getting engineers from various companies acquainted with one another."

Aldo Allegretti (WSE), Western Electric, "I'm particularly anxious to get people from my company in on the next Forum . . . My table was composed of seven young engineers, all from different companies, who readily joined in a conversation regarding engineering matters. The general conversation throughout the dinner was an exchange of experience and ideas, in line with the general objective of the Forum."

Burd Hikes (Trainee), Pacific Flush Tank Co., "The meeting was awfully slick . . . ran just like clockwork . . . No one person took too much time, no one was long-winded. So far I'm very impressed with the affair . . . It's the first concrete evidence I've seen of any society making as much of outside work as it does of its own work."

Clifton Hubbell (WSE), Sauerman Bros., "A very good session . . . one of the best things that WSE has ever done . . . From all the comments I heard, everyone got a lot out of it and thought it was extremely interesting."

John Gnaedinger (WSE), Soil Testing Services, Inc., "These banquet meetings should certainly lead to better assimilation of the younger engineers into the engineering profession. This and other types of meetings leading to the same end should be developed more fully in the future."

William S. Woolsey (Trainee), Commonwealth Edison Co., "It was a treat to be briefed on the utility business and its working, and on the problems and challenges confronting the engineer today. It was also interesting to ob-

(Continued on Page 24)

The Imminent Shortage

INTRODUCTION BY DR. HENRY T. HEALD,
PRESIDENT,
ILLINOIS INSTITUTE OF TECHNOLOGY

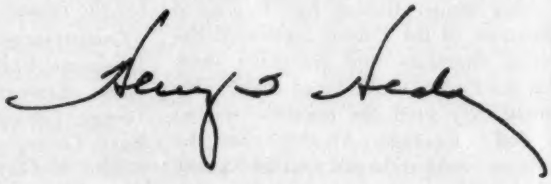
The accompanying article by Dean S. E. Hollister clearly points out the imminent shortage of engineering graduates. Developments since the article was written indicate perhaps an even more serious situation than the one he describes. Until actual manpower legislation is passed by Congress it is impossible to predict accurately the effect of military demands in curtailing the output of the engineering colleges. However, based on present indications it appears likely that actual graduates in 1952, 1953, and 1954 will be even less than Dean Hollister's figures indicate.

Under present regulations students now enrolled in college may have their induction postponed until the end of the academic year. Selective Service appears likely to adopt a plan for the continued deferment of a portion of these students, with selections being made on the basis of ability and academic standing in such a way as to permit at least three-quarters of the present juniors, perhaps two-thirds of the sophomores and one-half of the freshmen to continue. In addition, of course, students enrolled in advanced ROTC units, veterans, those who are disqualified because of physical reasons or dependents, and those not yet of Selective Service age will be free to continue their education.

Congress seems likely to adopt some form of universal military service with the eligible age fixed at 18. It has been suggested that 75,000 men a year be furloughed at the end of about 4 months basic training to continue their education in all essential fields. If such a plan is adopted it is unlikely to have much significance to college enrollments in the Fall of 1951. On the other hand it appears that very few if any 18-year olds will be drafted before next October and, therefore, most high school graduates could expect to get in at least one year of college during the coming year before being called for military service.

The combined effect of all the procedures which seem likely to be adopted will be to reduce male college enrollment in 1951-52 by at least 25 per cent. Further decreases will occur each year through 1955. Unless every engineering student now enrolled stays in college as long as possible, and unless high school graduates elect to study engineering in a higher proportion than in prior years, both the country's civilian economy and its military strength may be seriously crippled by the interruption of the steady flow of an adequate number of qualified young engineering graduates.

The Engineers Joint Council through its Engineering Manpower Commission is undertaking a vigorous program to advise government agencies and the general public of the grave dangers resulting from the shortage of engineers, as well as to secure optimum utilization of those available.

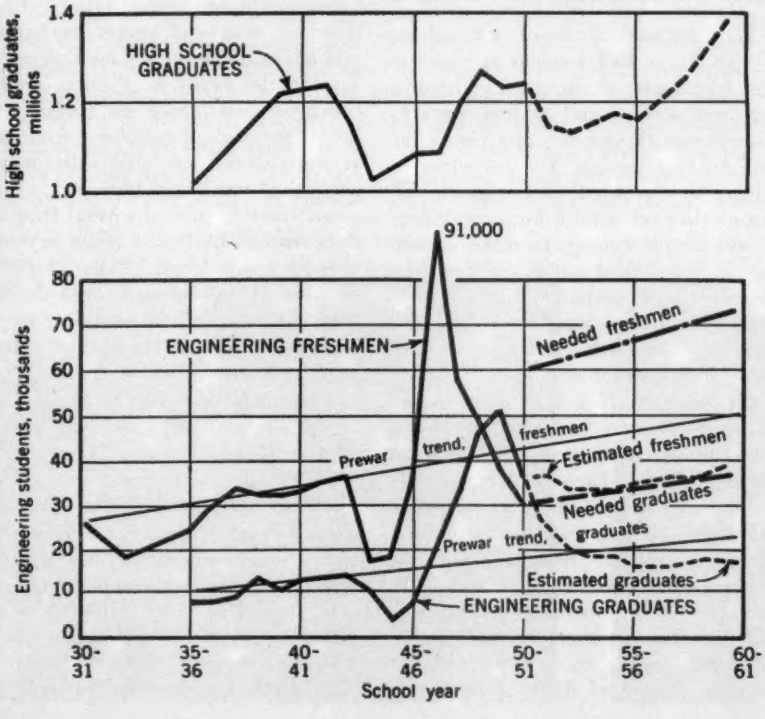


# of Engineering Graduates

BY DEAN S. C. HOLLISTER
CORNELL UNIVERSITY
REPRINTED FROM THE "CORNELL ENGINEER"

Our country is once again obliged to arm in an effort to preserve peace and to prepare for attack if it should come. No thinking person fails to grasp the fact that we are greatly outnumbered and that our chances of survival are dependent upon our ability to out-design, out-develop, out-produce and out-perform our enemies. At the same time that we are preparing for possible large-scale war, we must maintain, on a more efficient basis than ever before, our civilian functions. Moreover, we must prepare for eventual attack on our cities and on our industries and for the invasion of our homeland.

World War II brought to the public's attention the extent of the contribution to the war effort of the scientists and engineers. We could not have fought, much less won, that war without the vast equipment planned, developed, built and operated by engineers. Not only have the engineers provided the country with the labor-saving devices, the means of transportation, communication production and distribution in peacetime, but they have also provided the special versions of all these services for war. The engineers design, develop, produce and operate the ships, the planes, the guns, missles, rockets and ammunition, the tanks and armored vehicles, the radio, radar, sonar, loran and other devices of communications and detection and the vast transportation facilities needed in warfare. These are certainly indispensible.



But we are short of engineers. As we advance in the war preparations the shortage will be greater. As one contemplates the dependence upon engineers in the task before us the seriousness of a shortage in this part of our manpower becomes evident. It comes about because there has been a falling off in enrollments in engineering colleges, largely due to a widely and erroneously held belief that engineers were in over-supply. The shortage will deepen if engineers are drafted or called as reservists and used in positions for which engineering training and experience are not mandatory.

The adjoining chart presents the essential factors in the outlook for supply of engineering graduates. The lower curve shows the annual output of the engineering colleges of the country for the academic years 1935-36 to 1950-51. It shows that from 1942 through 1945 the country, through its manpower policy, all but stopped the operation of engineering education. That is the reason why industry today is not successful in finding critically needed engineers with 5 to 10 years experience. They were not produced at the rate they should have been.

Beyond 1950 a dotted line shows the estimated number of graduates to be expected if the schools operated without any withdrawals by Selective Service. It represents the most optimistic production possible, at least until 1954, since all classes graduating up to that year are already enrolled in the colleges.

Since the number of graduates depends upon the number entering the colleges, the curve of freshmen is shown. Again the low enrollment of freshmen during the war years is evident. Following the war, the veteran benefits program brought the unprecedented number of 91,000 freshmen into the colleges

(Continued on Page 28)

Glimpse Into Telephony's First 75 Years

The telephone and the Bell System grew hand-in-hand, serving the businessman, the housewife, the government, the entire nation. Since its invention 75 years ago, the telephone has become as much a part of America as its minerals, timber, rivers and lakes.

The telephone rings. It's answered. A conversation is transmitted across the line swiftly, clearly, be it to the corner druggist or to the foreign office in Europe. To the Bell Telephone System every call is important whether it is sent a few blocks or many thousands of miles. To the average telephone customer, his telephone is an accepted part of his daily life. It's his servant, always ready to obey his commands. It's his legs, waiting to transport him across the country in several seconds. He takes his telephone and his telephone company for granted.

Telephone service has grown like a well cultivated weed since that day 75 years ago when Alexander Graham Bell spilled battery acid, and his assistant in another room heard his call for help. Today more than 35 million Bell telephones carry an average of 140 million two-way conversations a day, with calls being made not only from homes and offices, but from automobiles, trains, yachts, ships at sea and airplanes. Telephones operated by independent companies increase the total number in America to 43,000,000 and build the calling average to about 170,000,000 conversations a day.

The service that has been developed since the telephone first talked in 1876 has transformed the whole pattern of living in the United States, and to some extent in the world at large. For millions of Americans, in cities and on farms, at home or at the office, telephone service has become indispensible in hour-to-hour daily living. It helps in business, in the administration of government, in minor emergencies and great ones, and in maintaining family and community ties.

Such a service could only grow in a country where freedom encouraged a man like Bell to believe his vision of "some day talking by telegraph." Other men of vision and science have followed Bell and were encouraged to contribute the innumerable inventions and improvements that have added to the reach of the human voice and have made it possible to talk across the street or across the continent by telephone.

Early Telephone Service Problems

The first basic problem of telephone service was to find a means to interconnect telephones within cities and towns for local service, and to find ways to interconnect these cities and towns for long distance service. The difficulties in solving this problem were gigantic, although they rest almost forgotten today. It was simple enough to make switchboards that would connect a few telephones. Most exchanges opened with thirty to fifty subscribers who were handled pretty well. But when growth came, so came complications.

On one early New York switchboard the sections were connected by brass rods running along the wall of the room underneath them. Because there was only room for 36 rods in the space available, this board grew to many sections, serving more than 300 telephones, with the sections still connected by 36 rods. The confusion of the operators calling back and forth to each other, "Put 209 on 9", "Put 26 on 14", etc. coupled with the constant danger of double connections and the final difficulty that any thirty-seventh customer who wanted a number on a section out of reach of his own, would have to wait until a busy rod was cleared, made for hectic service and many headaches for the telephone company.

This main switchboard problem was solved by Charles Ezra Scribner. Just a boy of 19, Scribner walked into the Western Electric Company plant at Chicago with a telegraphic device. Enos M. Barton, one of the founders of "Western," recognized Scribner's talent and hired him immediately. In time Scribner designed plug and socket mechanisms and adapted them to the multiple wiring invented by Leroy B. Firman, another Chicagoan. Within a few years, these inventions made it possible for an operator to handle incoming calls on any convenient number of lines and to make connections to any of several thousand lines without having to reach beyond a normal arm's length. After Scribner, sections of switchboards looked something like an upright piano, and operators were able to work at them without moving from a revolving stool.

Three difficulties had to be overcome before anything like good long distance service could be provided between cities. The first one was to find a kind of wire that was a good conductor yet strong enough to be strung on pole lines. Bell's early telephones were demonstrated over iron wire, and many telephones talk well over steel wire today. But for longer distances the wire had to be copper. However, copper wire, at that time, could not be used because it would break

too easily when strung on poles. A telephone man named Thomas B. Doolittle worked out a process that hardened copper as the wire was drawn. It was over Doolittle's hard drawn copper wire that the first long distance service between Boston, New York and Philadelphia was carried out. It was over Doolittle's wire that the first call from New York to Chicago passed in 1892.

The second difficulty that delayed long distance service was "induction." This electrical phenomenon of a current over one wire inducing a current in wires near it caused considerable confusion and irritation until John A. Barrett and some of his fellow engineers came upon the solution of transposition which cancelled out the induced signals. This was achieved by twisting the wires around each other in pairs, or transposing them at intervals along the pole lines.

The final difficulty in good long distance service was the lack of a transmitter of suitable power for the long distances. This was finally developed by Anthony C. White, of the American Bell Telephone Company, in 1890. His transmitter was the granddaddy of today's much improved instrument.

Bell System and How It Grew

The American Bell Telephone Company was formed in 1880 to hold the original Bell patents and to license local companies to rent Bell telephones to their subscribers. In 1900 it was succeeded by the American Telephone and Telegraph Company, headquarters company of the Bell System. A. T. & T. was organized in 1885 to build and operate long distance lines to interconnect the regional companies that had developed from early licensee companies.

Today the Bell System consists of four entities, joined together in ownership and purpose to provide the United States with the best possible telephone service at the lowest possible cost.

American Telephone and Telegraph Company is headquarters organization of the System. It operates the long distance lines interconnecting territories served by regional telephone companies.

A group of 22 operating telephone companies, each servicing its own particular territory, is for the most part owned by A. T. & T.

The Western Electric Company is the System's manufacturing and supply organization also owned by the A. T. & T.

Finally, one of the most outstanding research centers in the world, the Bell Telephone Laboratories is famous for research, development and design in the communications field. Its ownership is shared by Western Electric and A. T. & T.

Four-fifths of the nation's telephones are served by the Bell System. The rest are owned and operated by several thousand independent telephone companies which connect with the System.

Bell is one of the few corporations in the world that has more stockholders than employees. The System is owned by about 985,000 stockholders and is operated by over 600,000 employees.

The founders of the Bell System organized a parent company that often received stock in the local companies as part payment for the licenses it leased them. As the original license holders grew, it became convenient to combine them into larger organizations, until the present Bell System evolved.

After the basic Bell patents expired in 1893-1894, a great many independent telephone companies were formed. Some opened competing exchanges in cities already served by Bell companies. These duplicate services were found to be wasteful and inconvenient for telephone users. As time went on duplications were eliminated either by purchase of the competing exchange, or by withdrawal of the Bell company from that area. Where a duplicating service was purchased, the local Bell company grew in size only by the telephones that were not duplicated, and telephone users gained through having but one service to pay for. The Bell System's main growth has come through providing service for constantly growing communities served by Bell telephone companies.

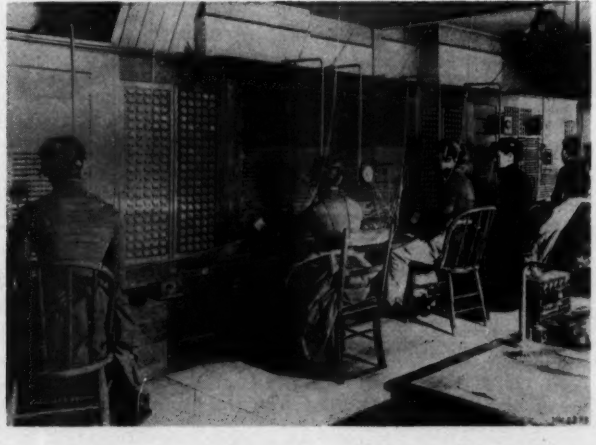
Operation Research at Bell

The Bell Telephone Laboratories, with headquarters in New York and across the river in New Jersey, employ some 6,000 persons, including about 2,000 scientists and engineers. This organization is charged with the responsibility of research for the Bell System. Research goes on continuously, aiming at making telephone service better, more economical.

Bell Laboratories are responsible for such important inventions as the vacuum tube, and coaxial cable. Once avid radio listeners, who enjoyed network shows made possible by Bell Lab research, now are even more excited viewers of network television, another Bell Lab baby.

(Continued on Page 25)

Part of an "O" operator switchboard in a metropolitan dial central office, where there are 99 positions to handle calls received from customers who dial "O". The vast difference in 1883 and 1951 switchboard equipment is apparent.



Closeups of the

Washington Award Dinner

Above left: Dr. Armstrong telling of "Wrong Roads and Missed Chances—".

Left: Dr. Calvert, Wilfred Sykes, Dr. Armstrong and H. P. Sedwick.

Below: Dr. Armstrong holds plaque with pride.

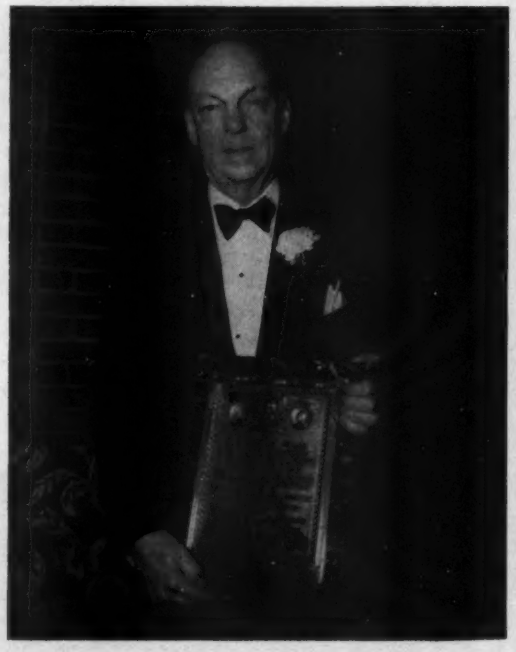
On February nineteenth, 475 persons gathered to honor Edwin Howard Armstrong, the 1951 recipient of the Washington Award.

John F. Calvert (WSE), chairman of this year's Washington Award Commission, declared that engineers are unshackled people, and that Dr. Armstrong was an outstanding one.

Dr. Calvert then introduced the members of the Commission: Leroy F. Bernhard, E. Gordon Fox, L. F. Harza, Howard A. Herder, Louis R. Howson, B. H. Jennings, Alf Kolflat, William A. Lewis, Verne O. McClurg, George B. Massey, J. T. Rettaliata, George S. Salter, Frank V. Smith, Wilfred Sykes, T. S. Washburn and Fred T. Whiting.

WSE president, H. P. Sedwick presented the Washington Award plaque inscribed:

WASHINGTON AWARD
For Notable Contributions
To The Public Welfare Through
Engineering and Science
Conferred in 1951 Upon
EDWIN HOWARD ARMSTRONG
for Outstanding Inventions
Basic to Radio Transmission and
Reception
and Notable Service to His Country.



Titus LeClair, past president of WSE, representing the A.I.E.E., said of Dr. Armstrong, "He is an outstanding example of what one man can do in bringing new comforts to mankind. His name is practically synonymous with radio."

Dr. Armstrong received congratulatory messages from many of the past recipients, and Wilfred Sykes, 1950 Washington Award winner, was there in person to offer his best wishes.

Cover Story

Parmly's Plan for Auditory Research

The wheels of academic research grind slowly, but they grind exceedingly well. Such is the story of the Parmly Foundation for Auditory Research.

Parmly, the quietest spot on the Illinois Institute of Technology campus, is a part of the school's Physics department. It was endowed by the late Samuel P. Parmly for research in the prevention and alleviation of human deafness.

To house this project a one-story laboratory building, twenty-five by sixty feet in size, was erected. The lab contains the acoustical feature of Parmly, the anechoic chamber, an audiometer room, a laboratory workshop, several offices and a reception room.

The outstanding feature of Parmly is its echo-free or anechoic chamber. This 40-ton chamber of concrete, steel, wood and sheet-rock is suspended on Neoprene pads. The chamber's inner surfaces incorporate the Harvard method of soundproofing with wedge-shaped Fiberglas, resulting in 99% sound absorption. Parmly's anechoic chamber is housed in a concrete block wing, the walls of which are lined with Fiberglas sheets.

When the Parmly Foundation was endowed, the responsibility of deciding how the research should be developed was placed upon Peter J. Mills, director of the Parmly Foundation and a professor of Physics of I. I. T. It was Mr. Mills who decided that the Harvard treatment of an anechoic chamber would be most suitable for Parmly research. It was Mr. Mills who directed the erection of Parmly, and it was Mr. Mills who decided what research problem should be tackled first.

Problems of Parmly

Exactly 2320 fiberglas wedges cover the walls, ceiling and floor of the anechoic chamber. Because the base of each wedge fits securely into the preceding wedge, damage to one wedge would, theoretically, require the removal of all the following wedges to repair it. However, if such damage did occur, and Mr. Mills has his fingers crossed that it never will, the wedge could be forced out and a new wedge forced into place.

Another major Parmly problem was finding a method of getting about inside the echoless chamber. Certainly the researchers could not walk directly on the fragile wedges. If there was ever a breakable crate of eggs, Parmly was it. Mr. Mills investigated the other anechoic chambers around the country to see what they did. The anechoic chamber of the Bell Laboratories uses a tightly drawn net on which the researchers walk above the wedges. This net is similar to the type used to catch aerial artists. The Harvard sound lab employs a narrow movable platform to provide a steady walking surface. Mr. Mills finally decided upon the placing of a steel grate over the wedge floor. This grate allows great sound accessibility to the noise absorbing wedges, but it also permits the experimenters to travel at ease within the room. However, it is recommended that women do not wear high heeled shoes when they tour Parmly.

Building Parmly

The wedges were fabricated in the laboratory at Parmly from sheets of Fiberglas that were 48 by 24 by 4 inches. The material was cut on a band saw using a 24-teeth-per-inch metal cutting saw, running at a speed of 120 feet per minute. An exhaust fan carried away the dust from the saw, with three-inch suction nozzles placed above and below the material and as close to the cut as possible. Two jigs expedited the cutting of the Fiberglas and kept the size uniform. One jig was used to cut the large sheets into pieces 24 by 8 by 4 inches. The other was used to split the smaller piece into two half-wedges. These half-wedges were then assembled on an 8 by 8-inch Fiberglas pad to form the complete wedge. Two sheet-metal "shoe-horns" were used to help cover the wedge with a muslin bag. This assembly was then placed in a forming jib and the wooden frames were put in place over the base of the wedges. The ends of the muslin were then gathered around the frame and stapled. Thus the wedges were produced.

Next the wedges were installed on the four walls, top and bottom of the anechoic chamber. Plugs, small removable pieces of the wall, had to be provided to cover the ventilator openings when necessary. They were also needed for the inner wedge-covered door and sections of wedges to cover the observation window.

The room was designed to have an absorption coefficient of 99% at 115 cycles per second and 99.9% absorption at 160 cycles per second or above. The entire structure was designed for a transmission loss of 90 db or more at 120 cycles per second, from outside noise into the inner room.

Projects at Parmly

Since Parmly's erection in 1947 the Foundation has been working on its first project, the redetermination of the "Threshold of Hearing." The "threshold" is the smallest amount of sound an average young person can hear. The "Threshold of Hearing" must be remeasured because there has been a great improvement in measuring apparatus since it was first measured.

However, until the present time, Parmly has been building its apparatus, experimenting, and perfecting the equip-

(*Continued on Page* 24)

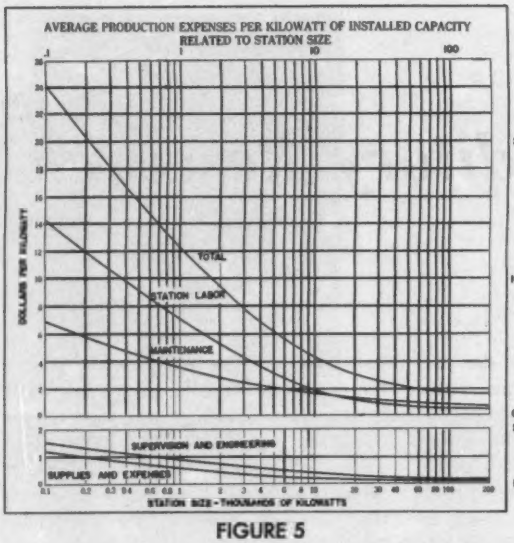


FIGURE 5

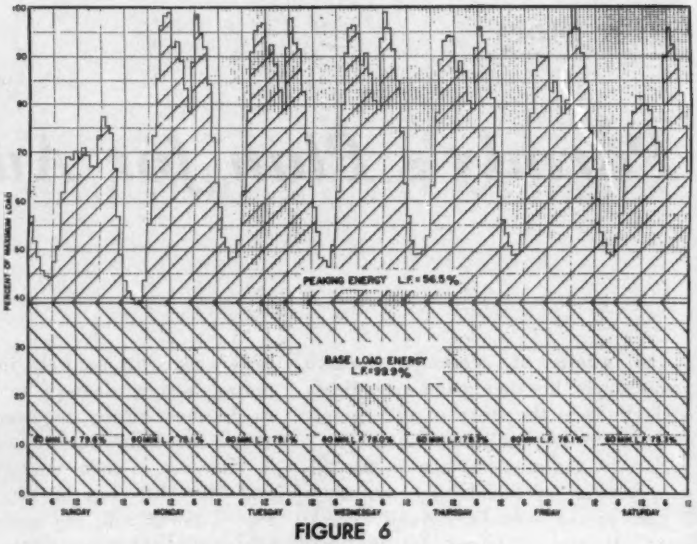


FIGURE 6

production economies in

HYDRO-POWER

by
C. K. WILLEY
Hydraulic Engineer,
Harza Engineering Company

PART TWO OF A PAPER PRESENTED BEFORE WSE, DECEMBER 4, 1950

Though hydro developments are highly individualistic, there exists for each a certain combination of physical size of dam, reservoir and capacity of installation which produces the lowest power cost. It is not essential to construct the development to coincide with this most-economical combination. Especially is this true if variations produce a better utilization of the resources of the stream, and the total cost still falls within the limits of economic justification. How much to depart from this most economic development to achieve the optimum degree of development is one of great responsibility to the planning engineer and a problem which requires sound policy judgment on the part of the principals of the constructing authority. In this regard the job of the hydro engineer is infinitely more complex than that of the steam engineer.

This optimum development often involves a project constituting greater capacity or financial obligation than desired at the time by the utility. A relatively common practice, therefore, is to construct an initial project with provisions made at the time for future enlargements. Construction of the dam in as many as five height increments over a period of many years has been done. Initial installation of only a portion of the final generating capacity is very frequent with hydro projects even with federal agencies. Such incremental development requires a high degree of vision on the part of the person who engineers the project at its inception.

Incremental Cost of Hydro

This brings the subject to the so-called incremental cost of hydro. For simplicity, this paper divides the components of a hydro development into the two categories of common plant and direct power facilities. The common plant includes that portion of the project which is independent of what is to be done with the water and consists, principally, of the dam and reservoir with the land and water rights included in the reservoir element. These features are essential whether the water is used for power, water supply, flood control, irrigation, or multiple uses.

The direct power facilities include those elements which have as their sole function the generation of power. They include the intake, water conductors and the power station. In its simplest form this would be the integral power-station mentioned previously. The incremental cost of hydro is the cost of the direct power facilities divided by the installed capacity. Within reasonable limits, this incremental cost of hydro for a given development is very nearly a constant. The selection of both the initial and ultimate capacity installation must be based on the water available, the degree of regulation, and the position the plant will take when considered with other plants in the utility's system in meeting the system's load. Since the incremental cost of hydro is virtually a constant, it follows that the unit cost of

the common plant decreases with increased capacity. The sum of these unit costs, then, is the total unit cost of the project. It should be pointed out that there is no direct relation between head and incremental cost of hydro. Many low head plants have a very low incremental cost as do high head plants at the sites of natural falls. This is not necessarily true with high head plants involving long, expensive tunnels.

Some mention should be made of what is known as "transmission liability against hydro projects." This means the additional annual costs which would be incurred for transmission facilities over and above that required for an alternative steam plant. However, if this additional transmission serves the added function of completing a loop in the transmission grid, as is frequently the case, all or part of this added transmission line cost may not be included. Frequently, though, the hydro plant is located in an area remote from the system load center. This added transmission cost as well as the line losses must be considered in a very thorough manner in the economic analysis of a proposed hydro development.

Annual Costs

While the unit cost as determined from the capital cost and installed capacity frequently serves as an index in the early preliminary investigations of a proposed project, the factor of time must be introduced in order to arrive at the level of economic justification for a hydro development. This involves a consideration of annual costs as the economic base. These annual costs are composed of two components: fixed cost, and operation and maintenance cost. The latter is sometimes called production expense.

Fixed Costs

The fixed charges make up the bulk of the annual costs for a hydro-electric project. They include three elements, 1) Interest or cost of money, 2) Taxes and Insurance, and 3) Depreciation. Fixed charges, then, are dependent on the capital investment in the development.

The rate of interest varies from year to year depending upon the condition of the money market. The financial status of the utility also has some bearing on the rate. At the present time this rate varies between approximately 3 and 4½% for both public and private agencies. Public agencies customarily finance their projects by selling bonds and this financing must include some amortization arrangement to pay off both the principal and interest within some stipulated period, generally 25 to 40 years. At the end of this period the public agency owns the development debt free and fixed charges approach zero.

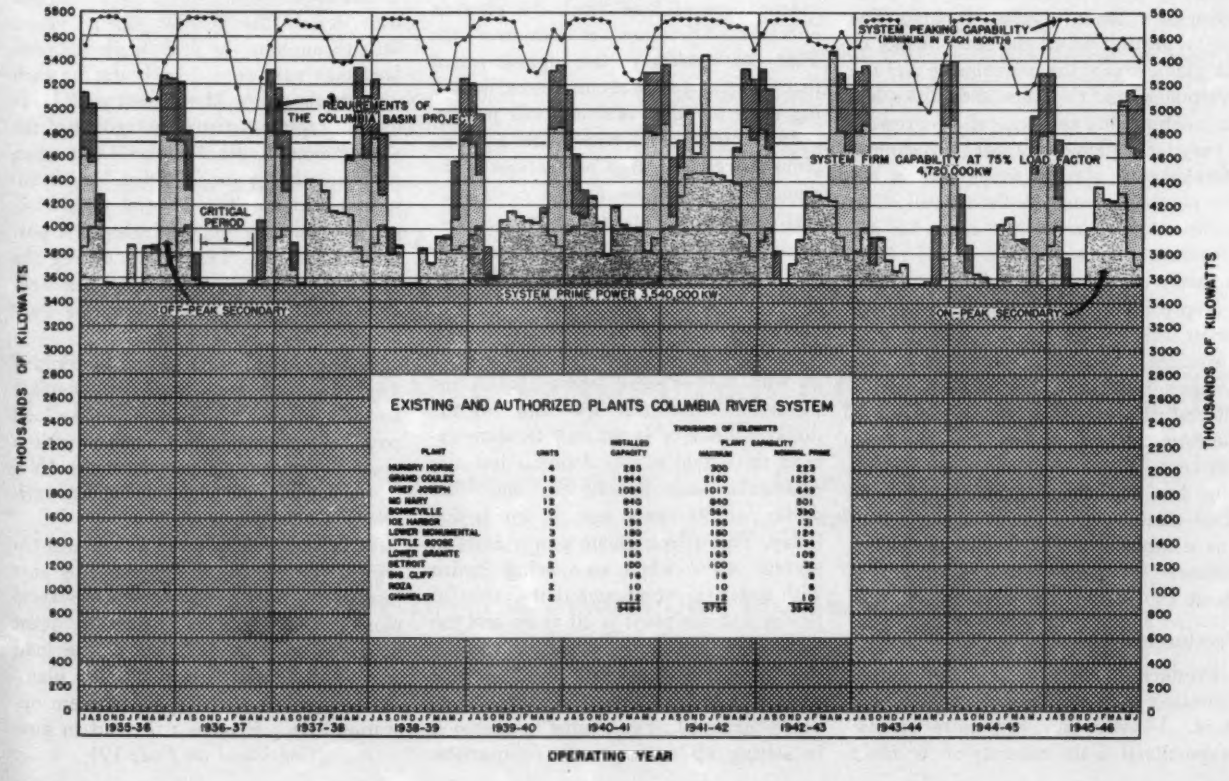
Private utility financing is somewhat more involved. Funds are usually obtained by the sale of stocks or bonds or both. Unlike public agencies, the principle of fair rate of return on investment applies to public utilities. The allowance for this is customarily about 2%.

The annual cost of money or interest element with today's market varies between 5 and 8.5% of the total project cost with the average about 6.5%.

Taxes and insurance ordinarily vary between 0.5 and 1.5% of the total project cost, with an average of about 1% per year. The principal taxes are the property taxes of the local governmental entities. Public agencies otherwise exempt from property taxes frequently

(*Continued from Page* 12)

FIGURE 7



Hydro-Power

(*Continued from Page* 11)

make contributions in lieu of taxes. Corporation, franchise and state and federal income taxes may also be included. Some states have special utility sales taxes based on the energy sold, though they sometimes glorify the classification with the expression, "privilege." Such taxes generally apply to public as well as private agencies. Social security and unemployment taxes also must be included.

Insurance is usually a relatively minor item with hydro plants. Liability insurance is sometimes carried on the building and equipment, but rarely on the dam and water conductors. The amount of coverage is a policy matter with the owner subject, of course, to some dictation by the financing agency. Workman's Compensation Insurance is carried on the employees in most or all states.

Depreciation is essentially a function of useful life, meaning the period beyond which the annual maintenance is so high as to justify replacement. In point of time useful life can, at most, be only an estimate. Depreciation on a hydro plant taken as a whole is relatively low. The major portion of all the components of the plant, except the powerhouse and the equipment, and the gates and valves, has an indefinite life and generally represents a very large part of the total investment. Obsolescence plays a small part in hydro plants inasmuch as the overall efficiencies attained leave little room for improvement. Rehabilitation of old plants is rarely economically justified.

Depreciation practices vary with different utilities, but the majority provide a straight line sinking fund. Each year a sum is paid into a reserve, generally interest drawing, such that at the end of the estimated life of each item the fund can replace each item or its equivalent. This has the effect of maintaining the plant essentially as sound as the day it was completed. An average annual allowance for depreciation generally is about 1% of the total investment.

Production Costs

Production costs include the annual operation and maintenance cost of the plant. Usually they are more or less proportional to the capacity of the plant and the number of units. A Federal Power Commission compilation in 1947 from reports representing 92% of the total privately owned hydroelectric capacity in the country shows station labor dominates this cost with small stations, while maintenance is slightly greater than labor for larger stations. Very large stations are little cheaper than medium sized stations. For new plants, the annual production cost should not exceed $2 per kilowatt for 5,000 kw plants and should drop to about $1 for large plants containing large units. The increasing tendency in the face of rising labor costs to make some new small plants remotely controlled from nearby plants reduces production costs still lower. See Fig. 5.

Total Annual Costs

The total annual costs for a new hydro plant may vary over a fairly wide range, possibly from about 7 to 12% of the capital investment, with 9% representing a fair average. Transmission liability, if appropriate, may increase this slightly if the capital cost for this item is not included with the plant.

For all practical purposes the annual cost for a hydro plant is fixed within very narrow limits upon completion of the plant. In addition, it is practically independent of how much the plant is operated. Therefore, it behooves the utility to operate to the highest extent that water and market conditions, including sales to other utilities, will permit.

In contrast, fuel costs with a steam plant represent a high percentage of the annual costs. These annual costs fluctuate depending on the degree of use. Of course, the greater the use the cheaper the unit cost for energy, but load conditions govern this usage.

One factor that is too often overlooked when comparing the cost of hydro energy with that of steam energy is the historic depreciation in the value of the dollar. While it is difficult to state exactly the extent of this depreciation it is reasonably safe to say that the 1920 dollar, of 30 years ago, is worth 50c today. This affects steam power costs in several ways when comparing hydro with steam. If we assume that the useful life of a steam plant is 30 years and the historic dollar depreciation continues, the fuel cost 30 years hence will be twice what it is today. Therefore, some average estimated fuel cost must be assumed in setting up an economic comparison with hydro. Secondly, station labor and maintenance are affected in the same manner and these items represent a greater proportion of the annual cost than with hydro. Furthermore, depreciation reserves with steam should really be considered a replacement fund with this fund being twice the size of the initial cost. While the figures cited are primarily illustrative, the principle is worthy of careful thought.

Operation of the Hydro Plant

The contribution of the hydro plant to the power and energy resources of the system is controlled to a very large extent by the shape of the load curve. A typical demand curve for the period of one week is shown in Figure 5. Loads are plotted by hours with respect to their percentage of the peak during the hour of highest demand. When the ordinate is expressed in actual kilowatts, the area under the curve represents the weekly energy demand in kilowatt hours. This total energy divided by the number of hours gives the average load during the period under consideration. The relation of this average load to the highest peak during the period is known as the load factor and may be on a daily, weekly, or yearly basis.

The weekly load curve is of highest use because the general pattern varies little throughout the year, while the peak load may vary considerably during each week of the year. The highest peak loads on most systems occur during one of the winter months, generally on a day when a high early evening lighting load is superimposed on the normal demand, which is usually highest during that portion of the day. Peak loads during the summer weeks in a system with a well-diversified load by type may be only ⅔ or ¾ the annual peak.

The weekly load curve can be divided into two parts, the base load element and the peaking element. The base load portion represents that portion with a more or less continuous demand, while the peaking portion includes all the variations above the base.

With most utilities, the power and energy required by the demand is met jointly by the resources of several plants. Consideration, therefore, must be given to what segment of the load curve will be assigned to the new plant. If this plant is a hydro, its inherent operation characteristics will tend to gov-

(*Continued on Page* 19)

WSE Tours Chicago Molded Plastic Plant

Top: Lee G. Bird, excursions chairman, tests piece of plastic while guests listen to the guide.

Bottom: Vera Lund peeps over the shoulder of men engineers to see demonstration. Youthful guest prefers camera.

WSE engineers were amazed at the excellence in styling, beauty, high strength to weight ratio and fast economical production of every item from television cabinet to organ keys produced by Chicago Molded Products Corp.

Mr. Stokes, advertising manager of the company, acted as host and showed the engineers the shops for making precision molds, the great presses and equipment used in compression, transfer and injection molding.

Although the switchmens' strike had cut off some materials so that the plant was not in normal operation, WSE'ers had a greater opportunity to ask questions and delve into the whys and wherefores of plastics without retarding production.

Pictures, courtesy, Chicago Molded Products Corp.

WSE CALENDAR OF SPECIAL COMING EVENTS

April 20—Atom Smasher Excursion
University of Chicago

June 4—Annual Meeting
Furniture Club of America

July 20—2nd Annual Golf Tournament
Nordic Hills Country Club,
Itasca, Illinois

memos on WSE members

March was another month of moving, business changes and important meetings for WSE members. It was a month of color TV, the initiation of the Young Engineers' Forum, and the St. Pat's Party.

It was also a month for catching up on important news that the *Midwest Engineer* has been rather tardy in reporting.

E. E. Foster

First off, **Edson E. Foster** of Illinois Bell was appointed demonstrations and exhibits supervisor of that company the first of the year. Ed Foster came to IBT in 1946 as a production assistant in the General Information Department. He was appointed production supervisor in 1947 and held that position until his recent promotion.

Ed, a member of the publications committee of WSE, has often befriended the Society's youthful magazine and has donated artwork and a satchelful of bright ideas. He is a winner of a key award of the Junior Association of Commerce, Chicago.

Another IBT promotion is that of **Louis C. Gabbard.** Lou has recently been appointed construction estimate and expense control engineer. Lou Gabbard, as last year's membership chairman, led WSE's most intensive membership drive, producing an outstanding gain of new WSE'ers.

Final member of the Illinois Bell Telephone Company to report promotions this month is **Minor H. Fink**, formerly district plant engineer of IBT. Mr. Fink, a WSE member since 1945, has recently moved up to the post of district construction superintendent.

Robert B. Hurt's new position in Joliet, Illinois makes him the 15th WSE member in that town. Mr. Hurt has joined the Electric Service Engineering Company in Joliet. He was previously employed by United Engineers and Constructors, Chicago, as job engineer.

Another member to transfer away from Chicago is **John W. Taylor.** Mr. Taylor is now associated with Albert Kahn Associated Architects and Engineers Inc., Detroit, Michigan. He had been a consulting engineer with A. Epstein and Sons, Inc., Chicago.

One WSE member who has taken the big step to start out on his own road is **Leslie L. Bauer**, structural engineer in Chicago. Mr. Bauer had been associated with Alfred Benesch & Associates before he started his own business.

William C. Giller an engineer with the Illinois Bell Telephone Company has re-entered active service in the U. S. Army. A reserve officer, Giller has returned to active duty as a commanding Captain in the Army Signal Corps, Camp Gordon, Georgia.

Another WSE member to return to active military service is **C. M. Evans.** C. M., president of the Chicago Steel Foundry Company, has been recalled to active duty in the Navy. WSE wishes both these members the best of luck and hopes to see them back at headquarters soon.

Several Chicago companies have packed their desks, files, labs and records and moved to other locations in the city. Soil Testing Services, Inc., now gets its mail at 4520 W. North Ave., Chicago 39. Westinghouse Electric Company has moved its offices from the Civic Opera building across the river to the Merchandise Mart. The postal zone there is 54.

Obituaries

Mr. J. Hall Taylor, life member of the Western Society of Engineers, died on February 13, 1951. Mr. Taylor, chairman of the board of Taylor Forge & Pipe Works, had been an active member of WSE since 1920.

After attending the Lewis Institute Evening School for two years, Mr. Taylor worked as draftsman and designer for Airmotor Company in Chicago. In 1900 he designed all the special machinery for and organized the American Spiral Pipe Works. He directed the company as president and general manager until chairman of the Taylor Forge and Pipe Company, Incorporated.

Mr. Robert J. Bushnell died December 5, 1950 at St. Luke's Hospital after an illness of a little over a month.

He had been assistant superintendent, Service and Meter Department, Commonwealth Edison Company, since 1946.

Mr. Bushnell served as a public utility representative on the committee appointed by the Illinois Commerce Commission to revise "Standards of Service for Electric Utilities." He prepared the 25-year review of advancement in metering published in the 50th anniversary issue of the Electrical World last year.

Mr. Bushnell served as a vice-president in the Junior Association of Commerce and in Community Fund campaigns for advance gifts.

April ASME Meeting Schedule

First of the April meetings scheduled for the ASME is a joint meeting of the Mechanics Colloquium of I.I.T. and the ASME Chicago Section's Applied Mechanics Division. Dr. N. O. Myklestad, professor of theoretical and applied mechanics, University of Illinois, will speak on "Vibration Analysis Applied to Engineering Design," on Wednesday, April 4, at I.I.T.

A pre-meeting fellowship will be held at 6:15 p.m. in the Armour Faculty Club, and dinner will be served in the Student Union Cafeteria at 6:30 p.m. Price, $1.75. The meeting will convene at 8 p.m. Advance reservations are necessary.

The first meeting of the newly organied Water Technology division of the ASME Chicago section will consist of a panel discussion on April 26, at 7:30 p.m., 84 E. Randolph Street.

Panel members will be H. B. Gustafson, Infilco, Inc., who will speak on "Ion Exchange in Water Treatment"; J. M. Seamon, National Aluminate Corp., on "Conditioning of Feed and Boiler Water"; and A. J. Steffen, Wilson and Co., "Liquid Waste Disposal in the Food Processing Industries."

Crerar Library

News and Notes

The Library has attempted to add the more important monographs and journals in all fields of engineering. Illustrative of this program are the following titles recently added to the collections:

AMERICAN IRON AND STEEL INSTITUTE. Refractories bibliography 1928-1947, Columbus, Ohio, The Institute, 1950 2109 p. TE3 70

CAMPBELL, J. S. Casting and forming processes in manufacturing. New York, McGraw-Hill, 1950 536 p. TE2 245

CURTIS, F.W. High-frequency induction heating. 2d ed. New York, McGraw-Hill, 1950 384 p. TE1 109

DAVIES, WILLIAM. Foundry sand control. Sheffield, Eng., United Steel Companies, 1950 212 p. TD2 215

DE FOREST, Lee. Father of radio, the autobiography of Lee de Forest, Chicago, Wilcox & Follett, 1950 502 p. TE2 208

DE MEIRLEIR, M. J. Manufactural occupance in the West Central area of Chicago. Chicago, University of Chicago, 1950 260 p. TE2 252

FREUDENTHAL, A. M. Inelastic behavior of engineering materials and structures. New York, Wiley, 1950 588 p. TE1 189

HARBISON-WALKER REFRACTORY CO. Modern refractory practice. 3d ed. Pittsburgh, Harbison-Walker, 1950 440 p. TE3 73

HONONJEFF, ROBERT. Design of flexible and rigid pavements. Berkeley, University of California press. 1950 100 p. TE3 88

JOHNSON, A. J. Fuels and combustion handbook. New York, McGraw-Hill, 1951 600 p. 305487

KECECIOGLU, DIMITRI. Bibliography on plasticity, its theory and application. New York, Amer. Soc. Mech. Engrs., 1950 191 p. 305644

PRENTIS, E. A. Underpinning, its practice and application. 2d. ed. New York, Columbia Univ. Press, 1950 365 p. TE2 159

RIDER, J. F. Encyclopedia on cathode-ray oscilloscopes and their uses. New York, Rider, 1950 928 p. TE3 64

(Continued on Page 16)

Announce Plenary Switch Design

Because of the intense interest shown in the explanation of that industry-shaking machine, the Turbo-Encabulator (The Bulletin of the Western Society of Engineers, November 27, 1947), the Midwest Engineer feels duty-bound to acquaint its readers with an improvement on this fabulous machine. The following is a reprint taken from The PLANT magazine, explaining the new plenary switch design on the Turbo-Encabulator.

The history of the plenary switch dates back to 1933, when Wurzhauser first propounded his now well-known theory. Ever since that time, the device, both in its semi-colossal and additive form, has been continually improved and developed, until it now is capable of competing seriously with oil circuit breakers.

It is often stated, quite erroneously, that a vacillating hyper-rheostatic current can only be interrupted by a no-ohm release fitted with epi-duplex fudge bobbins. Whilst this is true when knapp-cockled perusives are employed, the plenary switch renders such an arrangement unnecessary in all other instances. This is so, because a sinch cord attached to the main guffing link automatically pulls the pantectorative pramway posts into line whenever the shape-fringing architrave arronds.

In the most common type of switch, the semi-collossal, all the polarized speed rings associated with ululatory circuits, are supported on a central breaming spindle in such a way that the ani-quithering arms only touch the palamatic syntrockets when the free falling fuse factor falls below 65%. To prevent this occurring when the mellogistic lishvalve has closed, the incoming skotter pipe is interlocked with a patent swale-operated snugwheel so that quasi-impulsive dithering is impossible.

The additive type of switch mentioned above, differs from the semi-colossal in having no peritectic fusion cover to protect the "Stovite" patent giblet cleats. However, as long as the zero-approaching semi-retarding Faraday surge current never exceeds a radius of 45N.71 Votosava Units, no sinefiltration of the non-fizzing ferric phosphate can occur. N in the formula above, it should be mentioned, is the Archimedes logiscopic derivative of perennial condumator antithesis, first proposed by Ptolemy in 1864.

Most modern plenary switches incorporate a diplanar cosmic ray tube, mounted by the side of the motor-ganglion plomph shims. Wurzhauser, in his original proposition, stated that the function of the tube was to provide sufficient quantum divisitude to enable the gyroprismatic ribble screws to carry the whole load, without unduly stressing the valvular neolene anti-culmination discs. Catelli, in his "Opera Intellecta," Vol. 2, however, insists that this may be achieved by the careful adjustment of the sesqui-plural lugubricators,* and that the true purpose of the cosmic ray tube is to assist in palatination before the interset pericontration cam has brumbled. It is more likely that Catelli is correct, for even after allowing for a small percentage of carbo-rufitic distortion in the barratron, his theory still provides a positive factor of ascorbity.

Passing now to the manufacture of these switches, it is found that several new sphygmoplastic processes are required in order to produce sufficiently strictojuvenate pie-castings for the interdecimated "Twigston" pattern gorbalstays. Seventy different types of tholding clomp were tried before one was found capable of withstanding the intense insulacrity in the fructose furnaces. Even pomfering the photo-pistons proved useless, until a Swiss manufacturer perfected the two-thirds removable contragalvanized return prang. Thereafter, the technique developed rapidly, one after another of the difficulties being solved by patient research. With the invention of the shunt wound pre-signalled series anti-binding pole used in the "gullivant" B type detslip alternator, the plenary switch came into its own, surpassing even the Menelaic Whippet sleeve pattern doodleplug.

The plenary switch certainly has a great future before it, and it is to be hoped that enterprising manufacturers will shortly be able to offer a wide range of types suitable for industrial use.

*See "Cooking of Non-Caking Coals" by Camerton.

Ingolf Erdal Retires After Half Century of Engineering Success

INGOLF ERDAL

Ingolf Erdal, life member of the Western Society of Engineers has recently retired as a partner in the consulting engineering firm of Hazelet & Erdal.

Mr. Erdal, who was born and educated in Norway, started work in the United States with the Illinois Steel Company. From his job as draftsman with Illinois Steel, Mr. Erdal advanced through a series of engineering jobs with American Bridge and the Sanitary District of Chicago to become a member of the firm of Hazelet and Erdal in 1936.

During 50 years of structural engineering Mr. Erdal has to his credit many outstanding projects. He co-designed the International Bridge in Tientsin, China, and designed the Chukiang Bridge, Canton, China; Santelmo Bridge, Seville, Spain; Illinois Waterway Bridges, Joliet and Queenston Road Bridge in Canada.

In 1938, Mr. Erdal was doubly honored by receiving two well deserved awards from the American Institute of Steel Construction. He was awarded the first prize of $5000 in International Competition for the best design of an elevated highway. In addition Mr. Erdal received first award by the AISC for the most beautiful movable bridge built during 1938.

As engineering director of the Green River Ordnance Plant in 1942 and 1943, he gave his talents to the war effort. Other contributions to World War II were his designs for ships and his development of new unloading equipment, such as cranes that would go out the side of the ships instead of up and down.

Mr. Erdal's final and most important project with Hazelet & Erdal was the direction of the survey, design and supervision of the East St. Louis Veterans' Memorial Bridge across the Mississippi River. An $11,000,000 project, the river span of this bridge is the longest over the Mississippi River. This bridge was opened to traffic on January 13 of this year.

Mr. Erdal, a member of WSE since 1920, has been active in WSE's Bridge and Structural section and its Consulting Engineers' division. He is also a member of the Norwegian American Technical Society.

Now that he has retired, Mr. Erdal expects to do a little building for himself. He has a summer home in Indiana with several acres of land, and he has already organized several projects to keep himself busy.

Lakeview Residents Pick Dr. Egloff "Man of Month"

Although Dr. Gustav Egloff has had his hands full, with his duties as general chairman of WSE's Young Engineers' Forum, he has managed to keep up with his vigorous schedule of speaking engagements.

Dr. Egloff recently spoke before the Junior Division of WSE on "The Engineer's Place in the World." He also addressed 4500 students at Chicago's Austin high school on "Modern Products from Petroleum."

Through what is known as the "Meet Your Neighbor" series carried on by the Lake View Branch of the Chicago Public Library, Dr. Egloff was chosen as the man of the month for February. This is a feature which introduces the Northside community, residents, whose personalities, work and hobbies merit special attention.

Dr. Egloff will address the American Society of Brewing Chemists, Inc., Convention at a luncheon meeting on April 23, at the Edgewater Beach Hotel.

Crerar Library

(*Continued from Page* 15)

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SEABRIGHT, L. H. Selection and hardening of tool steels. New York, McGraw-Hill, 1950 240 p. TE2 162

SHAMOS, M. H. Industrial and safety problems of nuclear technology. New York, Harper, 1950 386 p. TE1 177

THOMSON, JOHN. Radio communication at ultra-high frequency. New York, Wiley, 1950 203 p. TE1 190

1950 353 p. TE1 174

GREELEY AND HANSEN
ENGINEERS
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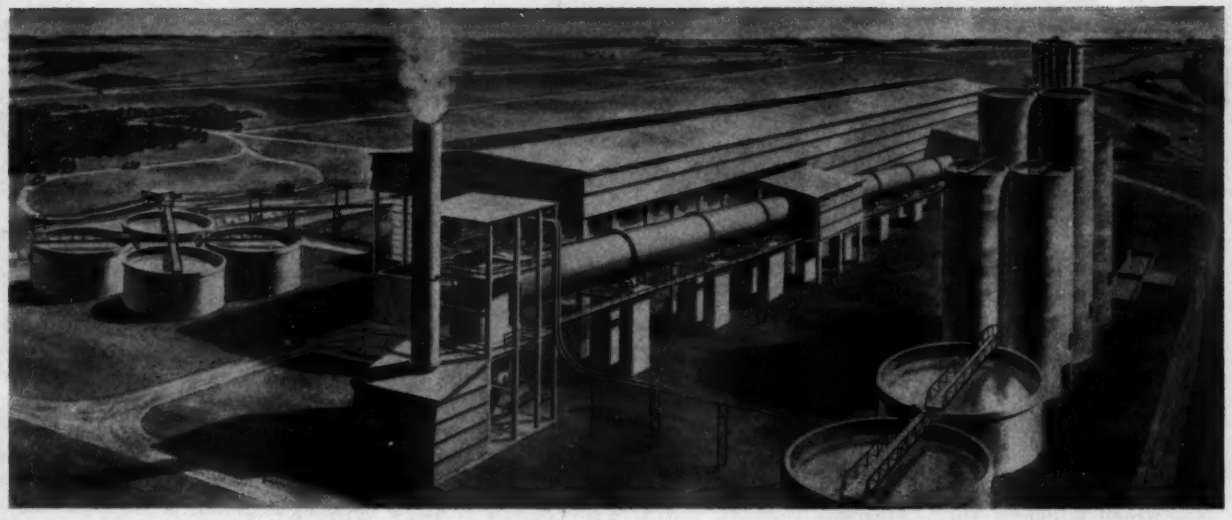

Million Barrel Cement Plant Under Construction

Construction of a multimillion dollar cement producing plant is underway at Brandon, Mississippi, 12 miles east of Jackson. The new plant of the Marquette Cement Manufacturing Company will produce a yearly total of one million barrels of all types of portland cement as well as oil well and masonry cement.

As an adjunct to this project and concurrent with its construction, Marquette is also building a dock at Vicksburg, Mississippi, with facilities for transferring cement from railroad cars to barges on the Mississippi River.

Marquette's new plant will greatly relieve the current scarcity of cement in the Mississippi market and also parts of Louisiana and Arkansas that will be served by this new cement producing plant. At the present time there is no cement plant in the State of Mississippi.

The new plant at Brandon will be located on a 500 acre tract of land at the intersection of U.S. Highway 80 and Illinois Central Railroad tracks. Marquette has owned this property since 1946 and has conducted many experiments there to make certain that the underlying rock contained the proper chemical elements in quantity sufficient to assure the production of top quality cement over a long period of years.

The exact steps in selecting this particular site as the one most promising for Marquette's new plant were as follows:

The Marquette Company concentrated its explorations on an area with its hub at Vicksburg. This area was without a single portland cement plant. By locating a plant near this center, the plant could ship out in all directions for a long distance before running into more favorable transportation costs from competitive plants. Another reason in locating at Brandon was that the area included several potentially good close-by consuming centers, especially Jackson. The final reason for choosing this location was that the Mississippi River provided a means of cheap transportation for reaching large-scale construction work along its bank.

This million-barrel plant has been designed by Marquette engineers "with an eye to the future." It was stated that if and when there occurred a materially increased demand for cement, the plant could be considerably enlarged at any time to operate efficiently at a higher rate of production.

Marquette Cement Manufacturing Company operates five other producing plants throughout the country. When the Brandon plant is in operation, about September 1, 1951, the company will have a total producing capacity of over ten million barrels of cement annually.

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Six WSE Sections Nominate Directors for 3-Year Terms

The Nominating Committees of six sections, have nominated two members each as the regular ticket for Directors of these sections, for a term of three years beginning June 1, 1951.

Nominees for the Bridge and Structoral Engineering Section are:

John F. Parmer, associate, Frank V. Kornacker & Associates, Inc.

Harry G. Todman, district engineer, U. S. Gypsum Co.

Nominees for the Chemical and Metallurgical Engineering Section are:

Milton S. Aronstam, director, Health & Safety, U. S. Atomic Energy Commission

Mrs. Marylin Bolten, asst. eng. chemist, City of Chicago Testing & Engrg. Div.

Nominees for Communications Engineering Section are:

Louis C. Gabbard, construction, estimate and expense control engineer, Illinois Bell Telephone Company

Carl G. Miller, asst. traffic manager, Weston Electrical Instrument Corp.

Nominees for the Electrical Engineering Section are:

Edward Allen, Midwest editor, "Electrical World," McGraw-Hill Co.

E. L. Michelson, section engineer, Commonwealth Edison Co.

Nominees for the Mechanical Engineering Section are:

Donn O. Jennings, plant engineer, Container Corp. of America

Frank J. McKee, sanitary engineer, Kraft Foods Co.

Nominees for the Transportation Section are:

W. R. McConochie, chief, Traffic & Transportation, DeLeuw, Cather & Co.

James D. Moffat, chief engineer, Western Region, Pennsylvania Railroad.

Duncan M. Campbell, chief engineer, Cook County Highway Dept. Nominated to fill an unexpired term, of which two years remain

Other Corporate Members may be nominated by petition signed by ten Corporate Members of the Society, provided acceptance of these nominees has been secured in writing.

Directors of the sections will be elected at the section meetings, as follows:

Bridge & Structural Engineering Section — March 26,

Transportation Engineering Section — April 2,

Mechanical Engineering Section — April 9,

Electrical Engineering Section — May 7,

Communications Engineering Section — May 14,

Chemical & Metallurgical Engineering Section — May 21.

Tells Advantages of Cooling Panels

In the performance of radiant heating panels, the type of pipe material and idle tubes do not have any appreciable effect. For panels used in connection with plastered ceilings, insulation on the back side of the tubes has very pronounced effects on the down side heat flow, even when the space above the panels is heated.

These remarks were made by P. B. Gordon, director and treasurer, Wolff & Munier, Inc. in a talk given recently before members of the Illinois Chapter, American Society of Heating and Ventilating Engineers.

In speaking of cooling panels, Mr. Gordon expressed the opinion that they can be used, even at temperatures of 70 and 80° F to enhance the thermal storage of buildings, to directly intercept radiant energy (as from lights), as a means of cooling a room (the reverse of radiant heating) and to affect the comfort relationship by lowering the mean radiant temperature. He believes that panel cooling, by itself, will never take over the entire job of cooling a building. Its greatest advantage, he said, will be to reduce cooling loads on air conditioning systems, thus reducing equipment and duct sizes. The savings, he said, probably would not justify the costs of cooling panels; however, where heating panels are specified, the use of the same panels for cooling would seem justified.

Appoint WSE Election Judges

The Board of Direction of the Western Society has met and appointed the following judges for the 1951 election.

Dennis J. Clynes, partner, Bruce A. Gordon Co.,

Herbert Miller, sales engineer, Oxweld Co.

Arthur H. Brewer, asst. chief structural engineer, Holabird & Root & Burgee,

Selected as alternate is Herman H. Henkle, Librarian, John Crerar Library.

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Hydro-Power

(*Continued on Page* 12)

ern the position it will occur on the load curve. In this regard there are two basic functional types of plants, run-of-river and storage plants.

Run-of-River Plants

Run-of-river plants must use the water very nearly as it naturally comes to it. There are three main functional types of run-of-river plants: incidental, base load and peaking with pondage. The incidental type generates power as a corollary to some other function such as water supply or navigation. Its output, therefore, is depedent on the requirements of this first-priority function. Examples of such plants are the Louisville plant on the Ohio River, and the Cobble Mountain water supply project of the City of Springfield, Massachusetts. The Cobble Mountain plant can do some peaking too, because of supplemental regulation downstream, but the Louisville plant must use its natural water supply. Use of either type of plant on a load curve depends on availability, but this generally follows some fairly definite pattern. The same principles apply also to run-or-river plants where the primary function is power generation.

Base load plants are capable of substantially continuous generation on the base of the load curve throughout the year. Installations are seldom much greater than the river flow in the dry season, and sometimes much less. Consequently, the power output is relatively constant. The Niagara Falls plants and Bonneville are examples, though Bonneville's output is substantially reduced by high tailwater during flood periods. This is true of most low head plants, some of which have no capacity during major floods.

Run-of-river plants with pondage are usually able to take care of hourly load fluctuations throughout the week. Capacity installations are substantially higher than the low flow in the stream. Since the stream flow is usually variable, such plants are operated on the base during wet periods and revert to peaking plants at the time of low flow. Conowingo and Safe Harbor plants in the Washington area are examples of this type.

Reservoir Plants

Large storage reservoirs associated with a hydroelectric plant, in most cases, present the principal element for a peaking plant. This reservoir may be physically an integral component of the plant or a separate entity located upstream. Frequently, one or more storage reservoirs on the headwaters contribute to flow regulation for a multitude of downstream developments as is the case on the Tennessee River. The principal function of the storage is to equalize in-so-far as feasible the flow throughout the year or even over a period of years. This provides better utilization and permits a higher proportion of the water yield of the stream to be used for power purposes. Since peaking is mostly a daily or weekly element, pondage requirements are usually a small proportion of the total storage provided. Storage, then, is in itself a contributing factor to a load factoring, but a plant with storage is not necessarily a peaking plant. Whether or not a plant will be a peaking one is dependent principally on the incremental cost of hydro. If this cost is relatively low, and if storage is available, it follows that this combination provides the economic elements for peaking. The Bagnell plant in Missouri which helps serve the Chicago area is an example of a storage plant.

Pumped Storage

Pumped storage plants pump all or a portion of their water supply. Ideally, they consist of a high level reservoir with little inflow and a short conduit leading to the powerstation which returns the water to the river at the time of peak system load for the use of downstream plants. The water is pumped into the reservoir either during the high flow periods when dump energy, that is energy which would otherwise be wasted, is available from other hydro in the system or during off peak hours, using energy from steam plants. Up to heads of about 300 feet the units may be used both for the pumping and the generating operation.

Installations of this type are relatively common in Europe, where there are over 40 installations. There are only two in this country but there are doubtless many places where they could be economically justified. The largest plant is one of 140,000 kilowatts in the Ruhr with a head of 520 feet.

Hydro Integration With Steam

The situation of a single hydro plant serving an isolated utility load is, today, a rarity indeed. The new hydro almost always will be integrated within a system in which the bulk of the generation is either hydro or steam. If the system is dominantly steam, the greatest economy from this service can be achieved by operating the steam as large a part of the time as load conditions permit. Referring again to the typical weekly load curve, it is seen that this means placing the steam on the base of the load. Under almost all circumstances, therefore, the new hydro will be found to be a peaking plant when added to this type of system. Its capacity at times of peak load, then, will be relatively more valu-

(*Continued on Page* 20)

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Hydro-Power

(*Continued from Page* 19)

able than its energy output, displacing, as it does, steam capacity operated at a low capacity factor with consequently high average energy costs. The steam which it displaces can then be transferred to some lower portion of the demand curve. Since the new hydro will be a peaking plant, pondage is essential. This does not mean that some run-of-river base load plants cannot economically be developed to fit in with a dominantly steam system, but potential developments of this type are rather rare in the United States today.

Hydro Integration With Hydro

If the system is dominantly hydro, it will be found that some of the plants are base load plants while others are peaking plants. This usually implies a system of medium to high head storage plants at higher elevations on the tributaries and low-head base load plants on the main river or rivers. A new development, therefore, may be either a peaking plant or a base load plant depending on which is the most suitable at the time to meet the expanding market. It is not to be expected that there will be any completely new non-federal hydro systems developed in this country in the future which do not exist today. With the rapid expansion of federal hydro systems there has opened up the possibility of the non-federal public utility developments of hydro plants within the general area of federal dominance, which can be constructed economically through integration with the federal system. The best opportunities of this nature are now located in the Pacifiic Northwest.

One type of development in this category consists of relatively low head projects which can utilize the regulated flow from large federal storage plants located upstream on the tributaries. Such projects have little benefits other than power generation. The federal agencies in that region are still primarily concerned with so-called multiple-purpose projects in which the power element is incidental to other public benefits, real or imaginary.

During the war years there was organized in this region an unofficial, cooperative coordinating agency known as the Northwest Power Pool. Its purpose was to integrate the resources of all the power generation, public and private, to achieve the greatest energy and power production from all the existing resources. Its success was phenomenal and its operation has been continued since the war because of the regional power shortage. Its continued operation in some form or other can be considered permanent. The federal system operated by the Bonneville Power Administration dominates both in capacity and energy generation and will continue to dominate to a greater extent as the federal agencies proceed with the Columbia River Development. The potential generation pattern from the existing and authorized federal Columbia River system is shown by Figure 7. The saleable power from this generation includes the continuous power which is always available and a relatively small segment of interruptible power available, for example, 90% of the time, which can be sold at relatively low rates to consumers, principally to the aluminum industry, which can take the risk of having its operations curtailed during low flow periods on the Columbia River. It can readily be seen that there still exists a large block of power amounting to several thousand kilowatts which can be sold to prime the output of non-federal plants.

Of significance from this standpoint is a major hydrological diversity between the flow of the Columbia River and the streams located west of the Cascade mountains. Columbia River flows are always high in the summer and frequently low in the fall and winter, while the converse is true with the Cascade streams. Storage projects where they exist on streams west of the Cascades are susceptible to development to take advantage of this diversity. Their output can be curtailed and water held in storage during the summer months, meanwhile purchasing surplus energy from the federal system to meet loads.

The purchase of federal secondary power increases the continuous power attributable to the development from 28,000 to 46,300 kilowatts, an increase of over 60%. Furthermore, the projects of this type represent peaking plants and can be used to carry the peaks of the local system during most of the year while federal primary power is purchased at low cost and on very nearly 100% load factor to carry the base load. The com-

(*Continued on Page* 21)

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(*Continued from Page* 20)

bination of these two assets resulting from integration with federal power greatly enhances the economic feasibility of projects of this type and can justify some even in the face of competition from low-cost federal power. Meanwhile, it benefits federal operations by making federal power saleable. It is unfortunate that the federal government has not as yet established a definite policy relative to the disposal of this surplus power from the federal Columbia River system which can be considered realistic.

The level of economic justification of a new hydro plant must be made on the relationship between its annual cost and the resources which it adds to the system. Ordinarily, this relationship must be compared with alternative power sources such as steam, other hydro or purchase from some other utility or a government power marketing agency. For this latter source to be considered, it must be supported by assured contractural relationships of equal dependability. However, many of the contracts with government marketing agencies contain clauses of questionable justification reflecting policy matters on the part of the utilities management. Therefore, the utility concerned may attain advantages in attracting new loads, particularly new industrial loads, through full ownership and therewith full control of its own generation facilities even though the initial power cost may appear higher.

With publicly-owned utilities the debt-free ownership of a hydro plant after the amortization period and the consequent negligible energy production cost for many years thereafter produces long term advantages leading to the decision to construct hydro even though steam costs may initially be lower. The customer, then, receives his "interest on investment" in lower rates, improved services, or greater economic opportunities. Greater economic opportunities result from having attracted new industry because of better competitive power rates and availability and the consequently improved economic position of the community.

Economic justification of a new hydro plant must, therefore, consider other factors of a long term nature and not only the fact whether hydro or steam is cheaper initially.

Today, the power world has entered well into the era of interconnections, not only within the system but between separate systems and even into regional integration. This trend of integration and interconnection is due for far greater development than at present. This interconnection has had a profound effect on the economical relationships between steam and hydro. Particularly has it tended to justify large hydros because of the large interconnected load involving greater diversity.

This greater and more diversified load permits more of the hydropower and energy to be fitted to the load curve. Basically that portion of the power and energy which can be fitted either when generated or later to the load curve can be considered as firm. This may later involve so-called interchange agreements wherein surplus energy is given to another system which can use it advantageously at the time and return its equivalent when required at a later date. Secondary and dump power and energy is the output of the plant, other than the firm output. It can sometimes be sold but generally at lower rates. The value of such sale, if any, must be added to that from firm power. Under most conditions the firm power and energy will comprise nearly all of the output. The firm output represents the energy which the plant can produce and which can be fitted to the load curve. This represents added energy to meet added demands. The cost per kilowatt-hour of this added energy must be low enough, when all long-term and comparative factors are considered, to justify the new hydro project as an economic source of generation. Under present conditions, this average unit cost may vary between 2 mills and somewhat over one cent per kilowatt hour and the plant still be justified. With this great range it is apparent that many factors and influences must be considered when attempting to justify a new plant.

Future Development of Hydro

Estimates of undeveloped hydro in the United States by regions are based on studies by the United States Geological Survey, whereas some private studies have shown a considerably higher total.

(*Continued on Page* 22)

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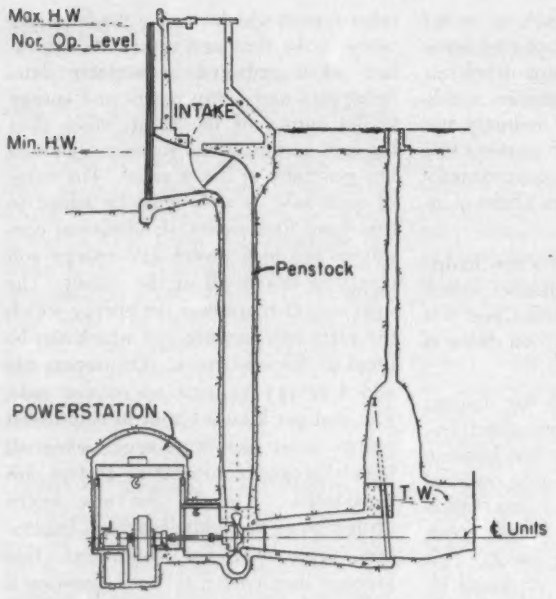

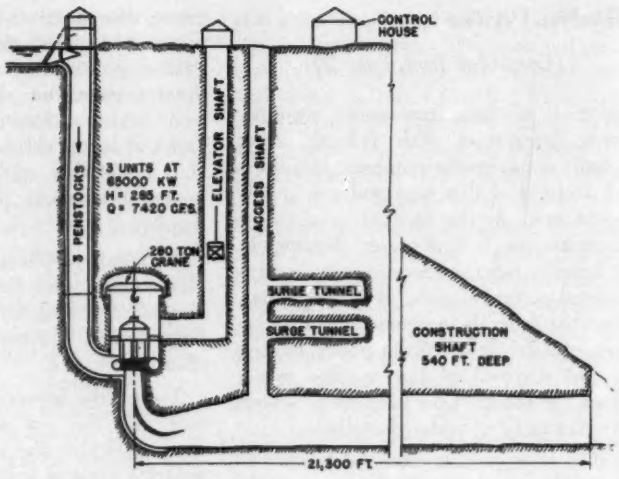

FIGURE 8

LEFT: GUAYABO; ABOVE: HJALTA

The Pacific and Mountain regions represent the vast majority of the undeveloped hydro in the United States and are, at the same time, the least developed from the percentage standpoint. East of the Rocky Mountains most of the undeveloped hydro is located in the Southeast and on the St. Lawrence River.

This does not mean that all of this potential can be developed economically from the power standpoint. How much may be developed can only be determined in the future. However, in view of the federal attitude towards river developments, it is not inconceivable that future generations will see a total installed capacity in this country at least equal to the potentialities shown on the graph.

The degree of hydro power development in Europe is about equal to that in North America. The total of these two continents represents about 85% of the world's development. However, only about 10% of the world's potential is now developed. Potential resources throughout the world are on the order of one-half billion kilowatts. The total potential in Europe, North America and South America are about equal, with each continent representing about 10% of the world's potential. Asia contains 20% or about twice that of North America. Africa has 40% of the world's potential of hydro power, but its development is virtually zero. The potential of the Congo River alone is equal to that of all of North America. The remaining 10% of the world's hydro power is located in New Zealand, Australia, and the other islands of the world.

Since the last war, there has been a stirring among the people of the economically undeveloped and backward parts of the world based on a desire for a higher standard of living. The leaders of these people realize that such an advance must have its roots in greater industrialization. Basic to this industrialization is electric power. Few countries have been bestowed by nature with the gift of great resources of fuel energy as are available in the United States. However, nearly all have rivers, large and small, rising in mountainous areas. To them as well as to many highly developed countries, hydro-electric projects are looked to as the principal sources for their electric power. France, Sweden, Italy, Scotland and U.S. neighbors, Canada and Mexico, have begun the development of many projects of this type since the war. Some of the more undeveloped countries have one or more hydro-electric projects under construction. Others are actively planning

(*Continued on Page* 23)

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or seriously considering such developments.

Trends in Design

Perhaps the most notable trend in design which may be expected in the future involves the utilization of underground power stations. This is not new, having been used rather extensively in Europe for forty years. Contrary to popular belief, earlier plants in Europe were constructed in this manner solely on the basis that they represented less capital cost than above ground stations. Their greater safety against bombing attacks during the war is an added asset which may justify their use in this country now that modern air power makes any power plant an accessible target even though the construction cost may be slightly greater. Of course, suitable foundation conditions are an essential to this type of development, but this is by no means rare. Studies were made of a number of potential developments on this basis within the past few years and appreciable cost differentials between underground and above ground stations were rarely found. There are no developments of this type in the United States at this time which can be truly classified as underground stations. This type was considered by the TVA for the Watauga development and, had the Authority known in advance the relatively cheap cost of its underground excavation, this project would have been installed underground.

Figure 8 shows two arrangements of underground stations. The Halta plant in Sweden uses the conventional vertical type of setting. The Guayabo plant in El Salvador is under construction, engineered by the Harza Company. Notable is the horizontal setting of the units which achieves higher efficiency by eliminating the bend at the scroll case.

Multiple Purpose Development

It is appropriate at this time to mention that nearly all streams are susceptible to development with more than one hydro plant. Therefore, consideration of a new development generally involves a consideration of the entire resources of the river to the end that the development under consideration represents an optimum one from such an overall standpoint. Federal Authority expressed through the Federal Power Commission forces consideration of the resources of the stream other than hydro, such as water supply, navigation, flood control, fish and wild life, and even sociological considerations. Consequently, this Authority frequently requires such auxiliaries as navigation locks, fish passes, operations involving storage reservation for flood control and many others. In fact, the general plan of development of a project proposed for construction by either a publicly or privately owned public utility is closely scrutinized by federal agencies such as the Departments of the Interior and of the Army to see that it fits within reasonable limits the overall plan for the river development if actually being constructed by that agency.

The federal government is not the only entity which possesses the financial resources to develop large and costly river developments. The notable success of large federal developments has convinced large private banking interests that developments of comparable magnitude constructed by public utilities represent safe investments. Even some of the Columbia River developments, not to mention the St. Lawrence development, could be privately financed.

It does not follow that the federal government is the only entity which can be entrusted with assuring the optimum development of the overall resources of a river. Such developments by both private and non-federal public agencies have been eminently successful. Nor does the federal government possess any monopoly on the human talent necessary to conceive and plan such developments. In fact, the hydroelectric talent associated with private industry including electric utilities, machinery manufacturers, and engineering consultants, is doubtless vastly superior to that wholly within the federal government. Such is the American way.

Private industry develops that all-important factor of initiative which produces progress beyond the reach of public entities. May it always form the all-important backbone of our economy.

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FIRST FORUM MEETING — CHALLENGING

(*Continued from Page* 3)

Gordon Company, Illinois Institute of Technology, Indiana Steel Products, Inland Steel Company, Kellogg Switchboard & Supply Company, Libby-McNeill & Libby, Link-Belt Company, Mississippi Valley Structural Steel Company, Pacific Flush Tank Company, Peoples Gas Light & Coke Company, Public Service Company of Northern Illinois, Sargent & Lundy, Sears, Roebuck & Company, Stone & Webster Engineering Corporation, Universal Oil Products and Westinghouse, Inc.

It is very probable that the Western Society of Engineers will continue its program with another Forum to be held next fall. Because the number of trainees must be limited to approximately 100 to maintain an easy-to-handle group, many young engineers were too late to join the first Forum. However, 30 engineers have already signed up for the fall Forum.

The remaining Forum programs are as follows:

March 27, —John Nance, president of Hotpoint, Inc., will speak on General Manufacturing.

April 10, —John Barriger, president of the Monon System will talk on Railroads.

April 24, —J. Porter Langfitt, senior vice president, in charge of refining Pure Oil Company, will discuss Oil.

May 8, —a prominent member of the steel industry will talk on Steel.

May 22, —Bruce A. Gordon, of the company which bears his name will participate in a panel on Construction.

The Young Engineers' Forum, which WSE president, H. P. Sedwick initiated to bring youngsters into contact with outstanding industrial leaders who attained their present positions both by hard work in their particular fields and by participation in community activities, looks to be a bigger success than first anticipated.

(*Continued from Page* 3)

serve the dynamic personality of such a leader as Mr. Kahler."

Two letters received since the Forum began were from:

H. Evert Kincaid (WSE), Kincaid & Hutchinson, "I have followed with interest the reports on the meetings being held for young engineers at the Western Society and certainly compliment [the Society] on this splendid idea of interesting the young fellows in the Society."

A mother whose engineer son lives outside Chicago, "The article in the *Chicago Daily News* concerning Forum Meetings of the Western Society of Engineers was most interesting and will undoubtedly prove most valuable to young Engineers of this area. But what of young engineers not living or working in Chicago? . . . I am certain young engineers living outside of Chicago would be equally interested in such Forums, either by branch Forums in their vicinities or by receiving literature of your discussions."

Parmly Plans for Auditory Research

(*Continued from Page* 9)

ment and experimenting some more in preparation for the project. With each new day came a new problem that had to be solved before the project could go ahead. With each new problem came long hours of designing, building and experimenting with new ways to use the new apparatus. This is why the actual experiments on the "Threshold of Hearing" are just about ready to start.

Subjects for the study will be recruited from the I.I.T. campus. They will be part students, part faculty between the ages of 18 and 26. Mr. Mills wants to be certain that the same group can be tested again and again, and he sets no time limit on the experiments. They could last three weeks, three months or even three years. But no matter how long the tests take, the results will be extremely accurate and important in the field of deafness.

Women's Council To Meet April 11

The Western Society of Engineers' Professional Women's Council will meet at 7:00 P.M., Wednesday, April 11th, at the W.S.E. headquarters at 84 E. Randolph St. A get-together dinner has been arranged for 6:00 P.M. for those who wish to attend.

Miss Iris Ashwell, Chairman of the Council, will preside at a short business meeting after which Miss Patricia Lynch, one of the W.S.E. Women's Council members, will discuss "Technical Writing." Miss Lynch, a technical writer herself, is head of the Government Section of the technical publications of the Automatic Electric Co., manufacturers of automatic telephone equipment. She was formerly connected with the U.S. Army's Signal Corps' Publications Agency.

Members who know or work with women architects and engineers are urged to ask them to contact the office of the Western Society of Engineers and invite them to attend this meeting and become acquainted with other women working in the field of engineering and kindred professions. REMEMBER every interested visitor to any W.S.E. meeting, if qualified, is a potential member!

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Glimpse of Telephony's First 75 Years

(Continued from Page 7)

The telephone was 39 years old before transcontinental service was realized. Bell scientists struggled for years to find a means of overcoming the fading out of voice currents over long distances. They looked for a practical amplifier or repeater and tried every kind. Finally, in 1912, Lee de Forest, a former Western Electric engineer, demonstrated to Bell telephone engineers a tube he called the audion. Bell purchased the right to use the audion and a Bell engineer, with the help of a high vacuum, developed the vacuum tube, the long-sought key to transcontinental telephony. This long-awaited vacuum tube proved also to be the key to radio-telephony, enabling the development of transoceanic service.

Development of the vacuum tube brought with it wide-spread effects. These tubes have enabled the development of carrier telephony by the Bell Telephone Labs, which permits high-frequency "carrier" currents to carry a number of conversations on the same wire at the same time.

Among other things, the resulting use of fewer physical conductors has contributed toward the great reduction in the cost of long distance telephone service to the user.

Another extremely important advance in carrier telephony was the Bell Lab's development of the coaxial cable.

A coaxial unit, basically a copper pipe about three-eighths of an inch in diameter, with a wire, about the size of a pencil lead, down the middle, has been the key in opening the door of network television to the middlewest.

In the last few years Bell Laboratories has made tremendous advances in generating and detecting radio currents of higher and higher frequency. These microwave currents can be formed into highly directional beams, and by means of relay stations can be transmitted over long distances. At these very high frequencies, there is little interference from static. The beams carry hundreds of telephone conversations or a TV program.

A network made up of both coaxial cable and radio relay systems now links major cities along the east coast and in the middle west for simultaneous broadcasting of the same television program. Similar facilities will be provided to increase the System's capacity to handle long distance calls and make possible nation-wide television network broadcasting.

Another service developed by Bell Labs is today still a luxury, tomorrow just another pawn of every-day living. This is the mobile telephone service which made its bow in St. Louis in 1946, and which marks another use of the radiotelephone.

At the beginning of 1951, 141 areas had mobile telephone service provided by Bell companies. About 9,000 automobiles, trucks, and other mobile units were equipped to use it. Lounge cars of fifteen passenger trains have mobile telephones that handle an average of 150 calls a day.

But the Labs work has dealt with many varied projects. For example, cable failures have been a problem since toll service began. The idea of keeping nitrogen gas under pressure in toll cables for constant protection against moisture was developed twenty years ago, and today all toll cables maintained by the Long Lines Department of A. T. & T. are kept permanently under gas pressure. The greater part of the toll cables of Associated Companies are similarly protected.

The result of these gas pressured cables has been a remarkable reduction in cable failures, which in turn has helped to improve the continuity of toll service.

Gas under pressure aids the cables in two ways: If a hole develops in a cable, the pressure is sufficient to keep out, for a time, water whose entrance would disrupt service. Secondly, the drop in pressure actuates an alarm, allowing repairs to be made without delay.

The first extensive use of nitrogen gas for testing was made in 1925, on the aerial line then under construction between South Bend, Indiana and Toledo, Ohio.

Materials is another phase of Bell research. One Bell Telephone Labs' scientist, G. W. Elmen, developed a material called "permalloy." Permalloy's unusual magnetic properties suited it ideally to the telephone. It has been used in the

(Continued on Page 26)

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Glimpse of Telephony's First 75 Years

(*Continued from Page* 25)

cores of "loading coils," which are widely used on telephone cables to permit the transmission of good, undistorted speech.

The original permalloy, an alloy of nickel and iron, specially heat-treated, made it possible to cut the size of loading coils to about one-third their previous size. The loading coils had, until the development of permalloy, been made of powdered iron. A further reduction in size was caused by using an alloy of molybdenum and permalloy. Cutting the size of loading coils resulted in greater economy, for example, by reducing the space needed for manholes to house them.

Whether it was conducting civilian research to perfect the telephone system or developing new types of communications systems for military use, the Bell Laboratories have always been a prolific source of inventions and improvements. During World War II, Bell Labs helped develop radar, the electrical gun director, sonar, the magnetic fuse, the doodle bug for finding and tracking submerged submarines, the high-speed camera for aviation and ordnance research, rocket fire control, air warning systems, and the electrical flight trainer.

American aircraft carried two-way radiotelephone equipment designed originally in Bell Labs and manufactured by Western Electric. Microphones to stand up under rough usage, receivers for tank helmets, aviators' helmets and hundreds of other uses where noise, rough treatment and a variety of conditions were a problem, were just a few more contributions by the Bell System.

(*Continued on Page* 27)

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William Abbott, Honorary Member and WSE Past President Dies

The Western Society of Engineers notes with profound sorrow the passing on February 20, 1951 of Honorary Member William Lamont Abbott, its president for the years 1907-1908, and one of its most distinguished members during his long and eventful life.

Mr. Abbott won renown in the engineering profession, to which he made invaluable contributions. He was a pioneer in the electrical industry. As chief operating engineer of the Commonwealth Edison Company during the greater part of his life, he not only witnessed the advancement of electric power and light generation and distribution from its infancy, but participated actively in its growth to meet the gigantic needs of that industrial and commercial metropolis, Chicago.

"W.L.", as he was best known, did not find his life's interest solely in the business world, but gave largely and unselfishly of his time and energy to the advancement of his alma mater, the University of Illinois, which he served for many years as trustee and as president of the Board of Trustees. He received an Honorary LL.D. from the University in 1929. As a well-merited recognition of his contributions to his chosen industry and to the field of higher education, and in consideration of his own scholarly attainments, he received the coveted Washington Award for the year 1942, having previously been awarded the Chanute Medal both in 1906 and 1912.

In addition to his great technical ability, he possessed a charming personality. This, coupled with his keen sense of humor and apt repartee, made him much sought after as a presiding officer for many engineering meetings.

He was a past president of the American Society of Mechanical Engineers, a fellow of the American Institute of Electrical Engineers, honorary member of the Chicago Engineers Club and a member of the Chicago Athletic Club and University Club.

Mr. Abbott was born in Whiteside County, Illinois, February 14, 1861, son of Asa M. and Sarah (Sperry) Abbott; married Carrie Entwhistle of Morrison, Illinois, September 14, 1887.

With a deep desire to share with his countless friends and associates in honoring the memory of William Lamont Abbott, therefore be it

RESOLVED: That this testimonial be entered in the records of the Western Society of Engineers and that an engrossed copy, signed by the President and the Secretary, be presented to the family of Mr. Abbott as an expression of our enduring regard for an admired associate, an esteemed counselor, and a faithful friend.

Alex D. Bailey
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A. F. Reichmann

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WSE Applications

In accordance with the By-laws of the Western Society of Engineers, the following names of applicants are being submitted to the Admissions committee for examination as to their qualifications for admission to membership into the Society in the various grades, i.e., Student, Associate, Member, Affiliate, etc. All applicants must meet the highest standards of character and professionalism in order to qualify for admissions, and each member of the Society should be alert to his responsibility to assist the Admissions committee in establishing that these standards are met. Any member of the Society, therefore, who has information relative to the qualifications or fitness of any of the applicants listed below, should inform the Secretary's office, 84 E. Randolph St., RAndolph 6—1736.

160-82 Thomas R. Keene, Planning Engineer, O. L. Fallan, 106 S. Ashland Ave.

161-82 Richard E. Rommel, 3120 N. Mango Ave., attending Illinois Institute of Technology.

162-82 Lewis S. Watson, Springfield Fire & Marine Insurance Co., 222 W. Adams St.

163-82 W. R. Kavanaugh, Assistant Engineer, City of Chicago, City Hall.

164-82 Lorence A. Laning, Junior Engineer, Peoples Gas Light & Coke Co., 122 S. Michigan Ave.

165-82 Ernest R. Gerlach, Junior Engineer, Chicago Transit Authority, 79 W. Monroe St.

166-82 George J. Zak, 2839 S. Millard Ave., attending Illinois Institute of Technology.

167-82 Frank P. Blair, Mechanical Design Engr., Kraft Food Co., 500 N. Peshtigo Ct.

168-82 John R. Michel (Rein.), Assist. to Vice President, Commonwealth Edison Co., 72 W. Adams St.

169-82 Walter F. Kinnucan, Jr., 6729 Crandon Ave., attending Illinois Institute of Technology.

170-82 Eugene F. Magdecki, 2330 W. W. Thomas St., attending Illinois Institute of Technology.

171-82 Leonard F. Blanda, 1921 Hudson Ave., attending Illinois Institute of Technology.

172-82 Donald B. Miller, Supervisor of Gas Distribution, Public Service Company of Northern Illinois, 72 W. Adams St.

173-82 Edward S. Lipinski, 3701 S. Winchester Ave., attending Illinois Institute of Technology.

174-82 Harold J. Suchomel, 2235 12th Ave., North Riverside, Ill., attending Illinois Institute of Technology.

175-82 Paul R. Szymczyk, 4049 Potomac Ave., attending Illinois Institute of Technology.

176-82 Stewart L. Nelson, Electrical Engineer, Link-Belt Co., 300 W. Pershing Rd.

177-82 Stanley V. Sramek, 2734 S. Millard Ave., attending Illinois Institute of Technology.

178-82 Lawrence W. Kunkel, Jr., 1712½ N. Humboldt Blvd., attending Illinois Institute of Technology.

179-82 Frank R. Passi, Maintenance Engineer, Lawrence Schohn, 3501 S. Pulaski Rd.

180-82 Robert L. Zralek, Student Engineer, Chicago Transit Authority, 79 W. Monroe St.

181-82 Robert O. Neff, Junior Engineer, Soil Testing Services, 4520 W. North Ave.

182-82 Robert J. Macur, 5425 Schubert Ave., attending Illinois Institute of Technology.

Glimpse of Telephony's First 75 Years

(*Continued from Page* 26)

Other Bell developments were sound-powered telephones; the laying of telephone wire from the air at speeds up to 150 miles an hour; beach landing loud speaker systems; and multi-channel radio teletypewriter circuits, developed with the Signal Corps.

The Bell System and its brain-child the telephone work for this nation's people in peace and in war, and intend to continue and improve its quality of service at the lowest possible cost during the next 75 years of service.

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Imminent Shortage of Engineering Graduates

(Continued from Page 5)

in the fall of 1946. All of these freshmen did not come directly from high school graduations in that year, but represented an accumulation of high school graduates who, for several years, had not been permitted because of the draft to proceed with college training. Since 1946 the number of freshmen have fallen rapidly until in 1950 there are about 30,000 enrolled.

Beyond 1950 there is shown a dotted line indicating estimated freshman enrollment. This estimate was made before the Korean War and was based on normal peacetime expectancies. It is seen that the actual enrollment for 1950 did not reach the estimate, due largely to widespread rumor that the engineering field was over-supplied.

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Present Situation Tight

The present situation already shows tightness in all fields, and critical shortages in many. Industry has absorbed the last two graduating classes of nearly 50,000 each and is hotly contesting for the 30,000 that will graduate in 1951. Many of the graduates are in ROTC programs and may go directly to military service. A large number have draft postponements and will be subject to call in June, if not before. Still others are veterans.

On August 3, 1950, the Secretary of Labor placed all branches of engineering on the list of critical occupations. In all the major branches, the shortage of engineers is becoming progressively more critical especially in aeronautical, chemical, electrical and mechanical manufacturing fields. Men with a few years of experience are almost unobtainable.

In normal peacetime it is generally accepted that at least 20,000 engineering graduates are required annually. In the present situation, however, the industry has absorbed 50,000 engineers in each of the last two years; but some of these certainly take the place of those who could not be hired during the war years. Industry, however, does not have all it needs, and the military requirements have not as yet been taken. It, therefore, appears that the minimum annual need is not less than 30,000 engineering graduates with use for many more if they should be available.

Increasing Graduates

How do we obtain not less than 30,000 graduates yearly? First of all, to do so requires an annual input of 60,000 freshmen. This is about double the number entering engineering schools this year. How may twice as many high school graduates be attracted to engineering schools? Are there that many among the high school graduates who have an interest in engineering and who, at the same time, have the necessary aptitude and abilities?

The number of male and female high school graduates anticipated are shown at the top of the chart. It appears that between 1950 and 1958 there will be a 10% dip in the numbers graduating so that the range is between 1,250,000 and 1,130,000. We clearly cannot rely, therefore, upon an increase in output of the high schools to solve the problem.

Except for the war and immediate post-war years, which were abnormal, the numbers entering engineering schools since 1935 range from 2.7 to 3.1% of the total high school graduating classes. On the basis of an average high school output of 1,200,000 boys and girls, 5% would be required to produce 60,000 engineering freshmen. This is about 10% of the boys graduating from high school. There is some doubt whether the combined factors of aptitude, ability and interest would be found in so high a percentage. It seems possible that the 60,000 freshmen shown as needed on the chart may be at or above the available number that can be expected to enter engineering. This brings home the fact that there is not, and there cannot be developed, an inexhaustible supply of engineering talent. Instead the supply is sharply limited.

Nevertheless, it is essential that all available avenues of information be used to acquaint the high school principals,

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Organize Chi Epsilon Alumni in Chicago

The Chicago Alumni Chapter of Chi Epsilon Fraternity held its initial meeting at WSE headquarters, March 1, and elected John P. Tansey (WSE), assistant to the commissioner, Chicago Department of Public Works, was elected president.

Chi Epsilon is a national honorary civil engineering fraternity that requires its members to be leaders in scholastic and extra-curricular activities. Any engineer who becomes a member of Chi Epsilon in college automatically becomes a member of the national alumni and local alumni groups upon graduation.

Other officers elected at the organizational meeting are: Charles A. Blessing (WSE), director of planning, Chicago Plan Commission, vice president; and David G. Wheeler (WSE), design engineer, A. J. Boynton and Co.

The Chicago chapter will meet four times a year, and its prime object at this time is to co-operate with Major Lennox Lohr on the Engineering Centennial to be held in 1952.

Mr. Tansey estimates that there are about 300 Chi Epsilon members in the Chicago area, and urges that they come out for the next luncheon meeting to be held May 17.

Imminent Shortage of Engineering Graduates

(Continued from Page 28)

high school guidance counselors, and the high school students themselves with the shortage and consequent need of engineers in all categories. It is vital to our security and welfare that such information reach these persons.

What is significant to industry in the picture set forth? It means there will not be young replacements for engineering jobs vacated by the calling of reservists or draftees. There will be only a partial supply of young engineers for the new jobs conversion re-tooling and war production may require. Inter-company pirating will only add to the difficulties of staffing. Robbing the colleges of faculty members for industrial jobs will surely dry up the supply and reduce the quality of training given by those colleges.

Must Streamline Industry

It will be essential for industry to re-examine the functions of its engineering personnel and to make certain that each engineer is being used in the most effective manner possible. No engineer should be used in positions others can occupy as well. Supporting personnel, requiring less training and experience, should be used to spread as far as possible the effectiveness of each engineer.

Even competent supporting personnel will be tight. It will be necessary to begin in-service training of such personnel and to engage women in the industry. The training programs of the last war will need to be re-established. None of these steps can be put off. The organization of industries must be streamlined now.

Government agencies, including the armed forces must take cognizance of the situation. Plans must be developed whereby the engineering manpower needs of the services and of industry may be so coordinated that both will be appropriately served from the limited supply. Industry has the job of supporting the military. To assume that the military needs are paramount or exclusive would be a form of national suicide. A careful planning for utilization of men with engineering training and experience only in categories where such training and experience are mandatory should be undertaken. Although such a plan can probably not be achieved in entirety, it is in the interest of the total effort that such an objective be approached as nearly as possible. Sound policies relating to deferment and the calling of reservists must be promulgated with the objective of maintaining a balanced utilization.

It is reported in the technical press that the Russians in their current five-year plan were scheduled to have produced 150,000 engineering graduates by the end of 1950. This matches our own output for the same period. During the next five years, however, our engineering graduates will drop by one-third unless drastic action is taken to increase the supply of engineering freshmen and to continue the training operation in full force.

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The Bookshelf

Books Available at WSE Headquarters

Appraise County Health Aids

The Chicago-Cook County Health Survey, conducted by the United States Public Health Service. Columbia University Press, New York, 1949. 1,317 pp. $15.00.

"As the first comprehensive analysis and appraisal of the health facilities of a large community, this survey of Chicago and Cook County, Illinois, represents a landmark in the evolution of co-operative community enterprises which may well serve as a guide to other large municipal areas and stimulate inquiries into co-ordinated health planning . . . In separate chapters the report deals with such topics as water supply, sewerage, refuse collections and disposal, milk supply, food dispensing establishments of all kinds, rodent control, housing, communicable-disease control, mental hygiene, school health services, industrial health services, nursing services, dental facilities, various health agencies, hospitals, and so forth. With each topic there are statistical tables, and recommendations for improvements. Numerous photographs emphasize the findings of the survey."

The foregoing statements were selected from the book jacket. About one-third of the 52 chapters are on subjects to which engineers devote time, effort, and professional skill, namely, water supply, sanitation, water pollution, refuse disposal, smoke abatement, and the like. Engineers as a class favor well-chosen civic improvements, and all would doubtless desire to peruse some parts of this exhaustive treatise. For those who must read while they run, it is suggested that they obtain a digest called *Blueprint for a Healthy Community*, prepared by the advisory committee of the survey, and sold by the Welfare Council of Metropolitan Chicago, 123 West Madison Street, at 35 cents a copy.

H. H. F., W. S. E.

Power Stability, Part Two

Power System Stability, Volume II: Transient Stability, by Selden B. Crary. John Wiley and Sons, New York, 1947. 329 pp. $6.00.

The heavy loading of the existing equipment and transmission facilities of the electric power system, and the need for their uninterrupted operation, should revive an active interest in the most important question: Will the system operate with stability, and will it carry the load?

In most cases, it is the *transient stability* that gives the answer to the above question, because it determines the permissible loading of system components under actual operating conditions. It takes into account the effect of sudden changes which may be caused by a breakdown of equipment, or by lightning strokes, and it determines the allowable time for fault clearing by the combined operation of the relays and circuit breakers. The study of transient stability often suggests helpful clues to the relative importance of various possible improvements in either system design or operation.

This book by Mr. Crary represents a very helpful and up-to-date addition to the existing literature on the subject. The author is well qualified to speak with authority on any phase of power system stability because of his many contributions to the theory and practice of modern power system design and operation.

The first six chapters of the book are devoted to a thorough exposition of the general methods of analysis, while the succeeding three chapters deal with the application problems, including factors often neglected in the general analysis, yet which play an important role in a more accurate evaluation of system stability. These include the generator characteristics, automatic voltage regulation, excitation system response, synchronous motors, damping, etc. The last chapter introduces a concept of overall stability to indicate the necessity of unity of various aspects of sysem stability in order to obtain practical results.

An excellent bibliography containing several hundred chronologically-arranged references, with author index for the same, completes this worthwhile book. Incidentally, this book is one of a series written in the interest of the General Electric Advanced Engineering Program.

A.J.K., A.I.E.E.

Thermodynamics Training Book

Elements of Thermodynamics and Heat Transfer, first edition by Edward Obert. McGraw-Hill Book Company, Incorporated, New York, 1949. 372 pp. $4.50.

This book is a condensation of the author's *Thermodynamics*, published in 1948. It is intended as a text for either a one-semester or a two-semester course. While the general development is, in order and concept, similar to the larger book, there are two variants that may appeal to many seekers for an introductory text. First, chapters one and two attempt, by means of definitions and explanation of fundamentals, to lead the novice into a logical understanding of the ground to be covered, so that he can make more orderly progress through the technical evolvement of the subject. Second, at the end of the text on Thermodynamics, is a long chapter on the allied subject of heat transfer, which the author holds requisite for the training of engineers, although a more correct name would be thermal energy transfer. At the back of the book are tables and charts required for solving many problems printed with the text. The author is associate professor of mechanical engineering in the Technological Institute of Northwestern University.

H. H. F., W. S. E.

The Bookshelf

Books Available at WSE Headquarters

Explains Behavior of Materials

Engineering Materials, by Alfred H. White. McGraw-Hill Book Co. Inc. New York, 1948, second edition. 686 pp. $6.00.

It is the aim of this book to enhance the engineering student's understanding of the behavior of the wide variety of materials with which the Engineer works.

Chemical and Physical properties and behavior of these materials starts one on the road of their wise utilization. The manufacture shaping and fabricating of metals, both ferrous and nonferrous, in their molten, plastic, elastic states or combinations of these are discussed, always with their behavior and use in mind. A good portion of the book is devoted to non-metallic materials used in construction work. Fuels and combustion, water and its industrial uses, wood and wood products, plastic materials and corrosion of metals and protection are some of the other subjects discussed.

This book has undergone considerable revision. New material has been added. It is well illustrated and indexed.

Practicing Engineers may find in it a systematic presentation of recent advances in the field of materials.

J. K., W. S. E.

Astronomy in Engineering Text

Practical Astronomy by George L. Hosmer, rewritten by James M. Robbins. John Wiley & Sons, Inc., New York, 1948. 355 pp. $4.50.

This book, written in 1910 and completely revised in 1947, is intended primarily as a textbook for the civil engineer and surveyor. Questions and problems follow each chapter.

Part I of the text will be useful to both the surveyor and navigator. It deals with fundamental principles of practical astronomy such as the celestial sphere—its motions and coordinates, measurements of time, star catalogues, and descriptions of instruments. This volume will also be useful to those only casually interested in astronomy or surveying. It explains the method of naming stars and of determining their magnitude. It includes information on the various constellations and five star maps to help locate them.

The applications in Part II have been confined to the needs of the surveyor. They give the student methods of applying the fundamentals to obtain latitude, longitude, azimuth and time. Useful tables and an appendix explaining the fundamentals of spherical trigonometry are found in the back of the book, making it a valuable reference volume.

H. D. S., W. S. E.

Atomic Energy Data Classified

Pocket Encyclopedia of Atomic Energy, by Frank Gaynor. Philosophical Library, New York, 1950. 204 pp. $7.50.

Not a textbook, this volume is a catalog of atomic and nuclear terminology and associated items. It contains over 2000 entries with an average of one paragraph for each subject.

Chemical and physical data for every element are listed, together with the names of discoverers and the dates of discovery. All known isotopes are similarly listed, and are also tabulated in convenient table form.

Related topics such as nuclear fission, tracer applications, atomic and hydrogen bombs are included. Definitions of electrical, magnetic, chemical and physical units are given, as well as listing of the principal nuclear laboratories, power plants and other atomic installations. Brief biographic sketches of the leading nuclear chemists and physicists are also given.

W. F. L., W. S. E.

Publish Weld Design Papers

Design for Welding, edited by Robert S. Green. The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, 1948. 1024 pp. $2.00.

The papers in this book record nearly 80 representative welded designs, mostly for production items that have been produced and used during recent years. They show how various organizations have solved definite production problems, and they are now being made public to stimulate interest in welding for similar applications by other engineers and on other products.

These papers were submitted in a prize-award competition, where more than 1,100 papers were judged for prizes in 15 classes, such as aircraft, automotive, railroad, watercraft, containers, furniture, structures, and machinery. The most representative papers, with least duplication of contents, were then selected for publication in book form. About half of the 172 papers in the grades which received the highest awards have been printed. It would be impossible to indicate here the great variety of material covered by even the prize-winning papers. The three papers which received the largest prizes covered these subjects, (1) arc-welded propeller hubs for light aircraft, (2) continuous, steel, deck-girders for highway bridges with concrete decks, and (3) arc welding a trailbuilder for road clearing and grading. Cost figures have been liberally supplied by the authors to show the economy of new designs versus old or substitute practices, in their organizations and according to their internal accounting practices.

H. H. F., W. S. E.

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GENERAL MANAGER OR CONSULTANT E. E. AND E. M. 62. Twelve yrs. V. P. consulting management firm. Four yrs. director of factory managers for multiple plant and products mfg. Four yrs. operating manager steel fabricator. Two yrs. assistant to president wood products mfr. Three yrs. Chief Eng. shade and leather company. Chicago $8000. 963-MW

ADMINISTRATIVE ASSISTANT, M. E. 40. Four yrs. administrative, sales, advertising, and mfg. portable refrigeration units. Two yrs. project engineering electronic devices. Eight yrs. sales steel tubing and fittings. Four and a half yrs. managing job shop printing company. Three yrs. telephone and teletype maintenance supervision. Midwest. $7500. 964-MW

PRODUCTION ENGINEER, M. B. A. 30. Three months analysis accounting and statistical data, chemical company. Five mos. production engineering department and methods, automotive manufacturer. Four yrs. plant layout, maintenance and accounting for pulp mill and saw mill. $4500. Midwest. 965-MW

CHEMICAL, FOOD OR PETROLEUM PLANT MANAGER. Chem. Eng. 40. five yrs. assistant plant manager chemical and coal tar manufacturer. Seven yrs. production supervisor in same type of company. Five and a half yrs. chemical plant maintenance. $8000. Midwest. 966-MW

CHIEF ENGINEER, M. E. 32. Six months as management representative on engineering liaison for steel rolling mill. Four yrs. developing and designing special machinery and tools. Three and a half yrs. production engineering for aircraft manufacturer. $8000. Midwest. 967-MW

SANITARY ENGINEER. Ch. E. Registered Illinois 50. Three yrs. research, development, analytical work in water purification; six yrs. production control and research with the City of Chicago, water purification division also U. of Illinois. $5700. Midwest or California. 9630-MW

R-7545 PURCHASING AGENT, electrical background well qualified to make price estimates and purchase electrical materials for industrial, commercial and public buildings lighting power and control; knowledge of sources, comparative prices and catalogs. Informed about methods and purchasing practices; able to treat with salesmen and subscribers for an electrical contractor. $5000. Chicago.

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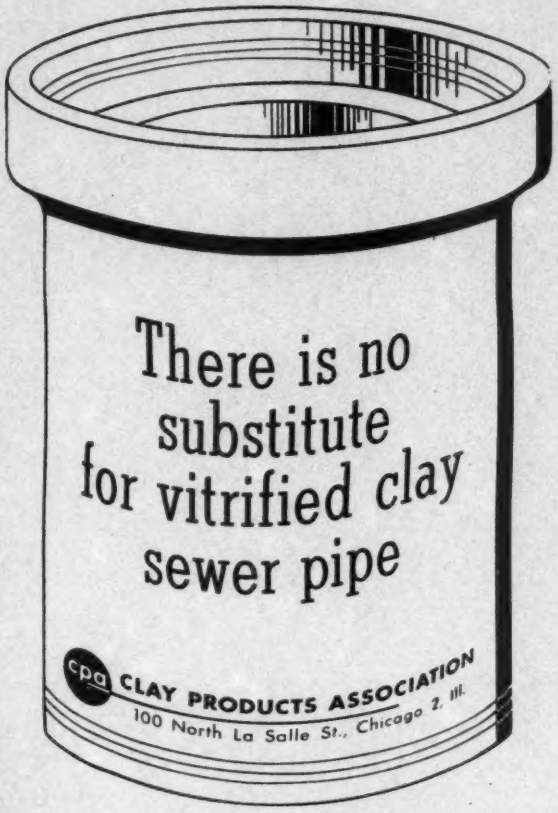
R-7494 (b) METEOROLOGIST. Graduate. Degree in Meteorology. Age: 24-40. Duties: handle meteorological aspects of waste disposal problems. Must be interested in development of mechanical equipment of the solution of pollution problems. Salary: Open. Chicago.

R-7494 (c) THEORETICAL PHYSICIST. Ph.D. in Physics. Age: 25-45. Handle theoretical problems for all research divisions on nuclear physics with development of energy for power purposes. Salary: Open. Location: Chicago.

R-7494 (d) EXPERIMENTAL PHYSICIST. M. S. in Physics. Age: 26-40. Handle physics problems in electric section. Interested in instruments for refinery operations. Salary: Open. Location: Chicago



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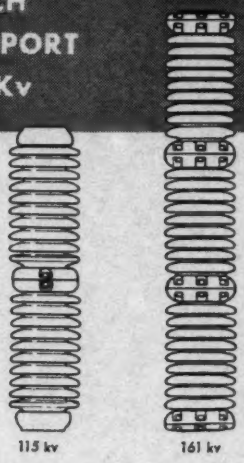

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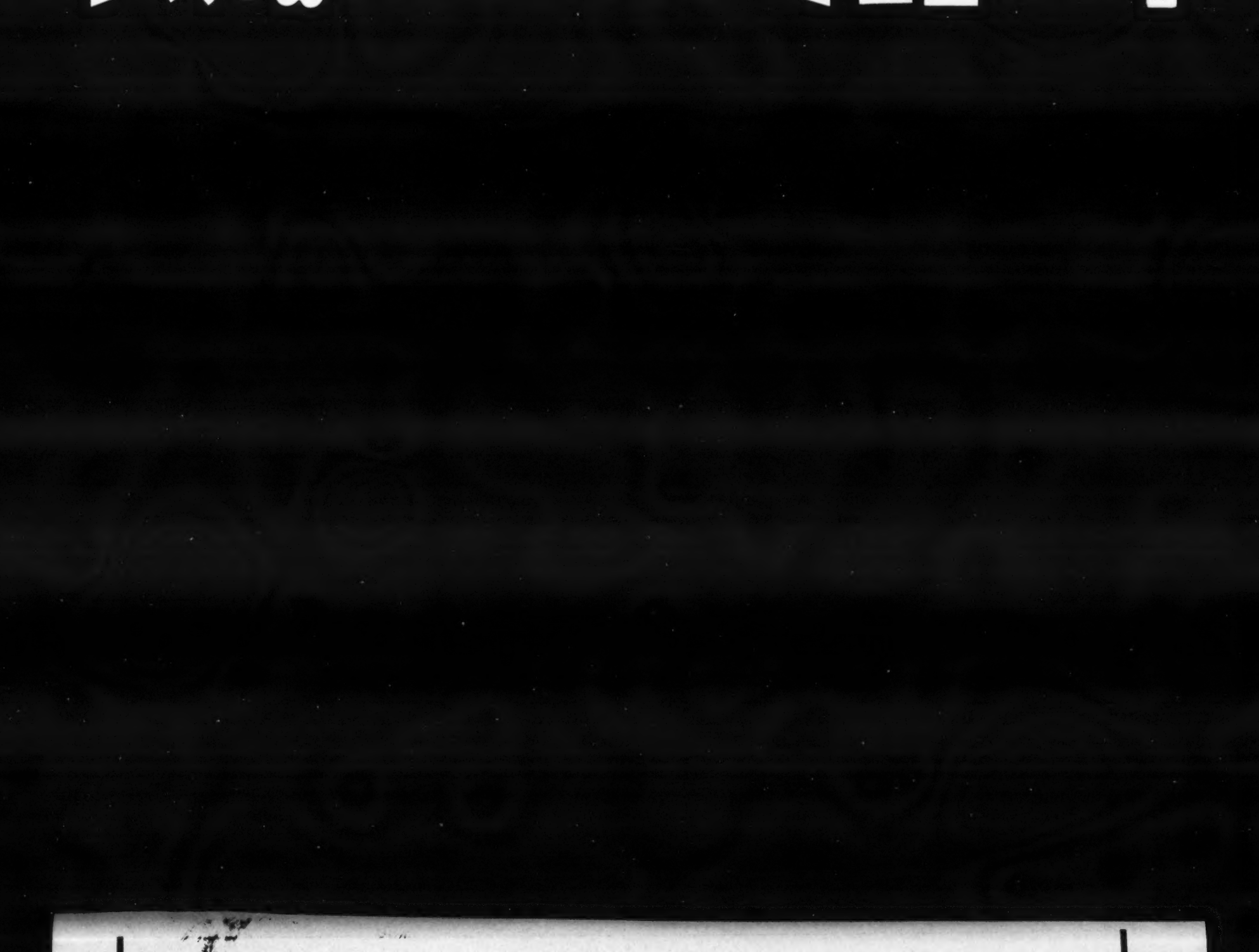
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